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Cultural Resources Inventory of the Central Mojave and Colorado Desert Regions, California

By

Dennis Gallegos
John Cook
Emma Lou Davis
Gary Lowe
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Cover design represents a petroglyph element from Corn Springs in the Chuckwalla Mountains, Riverside County, California.

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CULTURAL RESOURCES INVENTORY OF THE CENTRAL MOJAVE AND COLORADO DESERT REGIONS, CALIFORNIA

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Eric W. Ritter
General Editor
Riverside, California
1980

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FOREWORD

During a major planning project for the southern California deserts undertaken by the Bureau of Land Management during the 1970's, considerable effort was given to understanding the prehistoric and historic resources present. Management of these resources can best be effected if their character, pattern, distribution and significance are known or predicted, and from which research hypotheses and working models can be constructed for further work.

There are two major components of the cultural resources planning effort at the inventory level: (1) overview documents bringing together in a summary fashion previous works in archaeology, history, ethnography, ethnohistory and paleo-environmental studies, and (2) field sampling resulting in reports such as this. Ideally, overviews precede the field work in setting the stage for informed inventory. This ideal, however, is not always possible. In this case, both of the component studies were undertaken at the same time because of the limited time available between passage of the Federal Land Policy and Management Act of 1976 and the writing of the California Desert Plan and Environmental Impact Statement. The complementary work "A Cultural Resources Overview of the Colorado Desert" by Robert H. Crabtree, Martha Knack, Elizabeth von Till Warren, Claude N. Warren and Richard McCarty (1980) is on file with BLM in Riverside, California. The field inventory contract was awarded in May 1978 and the final report was submitted and accepted in April, 1979.

The inventory effort culminating in this document represents the first systematic effort at understanding the regional cultural remains. Prior to this work very little was known of the region. Even though the contractors were constrained by funding in the amount of inventory permissable, a quantum leap was made in comprehending the resources, and their distribution, significance and general meaning has been accomplished. This effort points up the distance left in securing a really meaningful handle on past human activities and contemporary environments in this central desert region.

The authors are to be commended for their field efforts during extreme desert weather conditions, and for their innovative methodologies with a balance of systematic and purposive sampling. They have taken a minimal amount of data and developed some reasonable and useful inferences and conclusions, hopefully to be pursued by future workers. They have also provided information important to judicious management.

While sections of this report are very technical, I believe the public will find the document as a whole to be informative and useful in a number of ways.

Eric W. Ritter
General Editor

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TABLE OF CONTENTS

Section	Title	Page
	FOREWARD	ix
	ABSTRACT	x
	ACKNOWLEDGEMENTS	xi
I	INTRODUCTION	1
II	ENVIRONMENTAL SETTING	4
2.1	Geomorphology/Geology	5
2.2	Springs and Seeps	5
2.3	Vegetation	8
2.3.1	Plant Communities	9
2.3.2	Ethnobotany	14
2.3.3	Discussion	19
2.4	Climate	20
2.5	The Late Pleistocene Environment	22
2.5.1	Bristol-Cadiz-Danby Lake System	25
2.5.2	Rainfall Based on Salt Content	27
2.5.3	Hayfield-Palen-Ford Lake System	30
2.5.3.1	Hayfield Lake	30
2.5.3.2	Palen-Ford System	30
III	RESEARCH - ARCHAEOLOGY	31
3.1	Objectives and Assumptions	31
3.1.1	Objectives	31
3.1.2	Assumptions	31
3.2	Sampling Design	32
3.2.1	Phase 1	32

TABLE OF CONTENTS (Continued)

Section	Title	Page
3.2.2	Phase 2	32
3.2.3	Phase 3	33
3.3	Phase 1 Sampling Strategy	33
3.4	Field Methods	37
3.4.1	Personnel	39
3.4.2	Dates of Fieldwork	39
3.4.3	Crew Qualifications	39
3.4.4	Transect Coverage	39
3.4.5	Field Problems and Site Identification Restrictions	40
3.5	Phase 1 Analysis	42
3.5.1	Observed Results	56
3.5.2	Stage 1 Site Projections and Distribution	59
3.6	Phase 2 Sampling Strategy	59
3.6.1	Phase 2 Sampling Results	66
3.7	Comprehensive Analysis	76
3.7.1	Site Preservation	76
3.7.2	Sample Characteristics and Density Estimates	86
IV	PHASE 3: PURPOSIVE INVENTORY OF SIX DRY LAKES	91
4.1	Introduction	91
4.2	Sketch of Study Area	91
4.3	Approach	91
4.4	Geoarchaeology of Five Dry Lakes	93
4.5	Individual Lakes and Their Human Records	95

TABLE OF CONTENTS (Continued)

Section	Title	Page
4.5.1	Bristol Lake	102
4.5.2	Cadiz Lake	109
4.5.3	Dale Lake	112
4.5.4	Ford Dry Lake	114
4.5.5	Hayfield Lake	114
4.5.6	Palen Lake	115
4.6	Retrospect	116
V	EXISTING RECORD AND SITE PATTERNING OBSERVATIONS	117
5.1	Existing Record	117
5.2	Site Type Observations	120
5.3	Site Patterning Observations	128
VI	HISTORY	132
6.1	Introduction	132
6.2	Historical Overview	132
6.3	Historical Background	132
6.4	Sampling Strategy	134
6.4.1	Sampling Results	134
6.5	Select Area Field Inventory	134
VII	FUTURE DIRECTION	136
VIII	SUMMARY	137
8.1	Inventory Description	137
8.1.1	Inventory Phases	137
8.2	Site Patterning	138
8.3	Locational Determinants	138

TABLE OF CONTENTS (Continued)

Section	Title	Page
8.4	Site Projection	139
8.5	History	139
8.6	Recommendations	139
IX	REFERENCES CITED	140

LIST OF FIGURES

Figure	Title	Page
1-1	Map of Study Area - Turtle Mountain, Bristol/ Cadiz, and Palen Planning Units	2
2-1	Hydrological Pattern of Water Flow and Spring Locations	7
2-2 a,b	a. Barren - Bristol Dry Lake with Amboy and Bristol Mountains in background b. Dune Scrub - Northeast Lake Cadiz	10
2-2 c,d	c. Creosote Bush Scrub - Creosote and Burro Bush on Alluvial Fan, Valley Bottom Area d. Yucca/Cactus Scrub - Turtle Mountains Catchment, Vidal Valley	11
2-2 e	e. Pinyon/Juniper Woodland - North End of Old Woman Mountains	13
2-3	Percent of Precipitation Falling During Six Winter Months at Selected Desert Locations	21
2-4	Modern Vegetation Map Taken from Calveg Study	23
2-5	Map Interpolated from Wood Rat Midden Analysis	24
2-6	Map of Pleistocene Lake System	26
2-7	Alkali, Bristol, Cadiz and Danby Overflow System	29
3-1 a	Turtle Mountain Planning Unit Stage 1 and 2 Sampling Strata and Transect Locations	34
3-1 b	Bristol/Cadiz Planning Unit Stage 1 and 2 Sampling Strata and Transect Locations	35

TABLE OF CONTENTS

LIST OF FIGURES (Continued)

Section	Title	Page
3-1 c	Palen Planning Unit Stage 1 and 2 Sampling Strata and Transect Locations	36
3-2	Hierarchical Model	46
3-3 a	Turtle Mountain Planning Unit Phase 2, Subregions, Subregional Blocks and Transect Locations	62
3-3 b	Bristol/Cadiz Planning Unit, Phase 2, Subregions, Subregional Blocks and Transect Locations	63
3-3 c	Palen Planning Unit, Phase 2, Subregions, Subregional Blocks and Transect Locations	64
4-1	Lakes of the Bristol-Cadiz-Palen Area	92
4-2	Bristol/Cadiz Planning Unit: Purposive Inventory	94
4-3	Palen Planning Unit: Purposive Inventory of Palen and Hayfield Dry Lakes	95
4-4	Archaeological Objects from Cadiz Lake	96
4-5	Elements of Desert Water Budget (Synergetic Landscape Interpretation)	97
4-6	Synergetic Landscape Interpretation	101
4-7	Apparent Relations of Lakes and Dunes: Palen Lake	104
4-8	Views of the Five Lake Valleys	105
4-9	Some Observed Relations of Dunes, Paleosols and the Playa of Cadiz Dry Lake	107
4-10	Diagnostic Artifact Portrait	110
5-1	General Pottery Locations and Types	124
5-2	Points From Within the Study Area	127
5-3	Stone Tool from Site PA-8, Chuckwalla Mountains	130
5-4	Stone Tool from Site TU-217, Turtle Mountains	131

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Number	Title	Page
2-1	Mountain Variables	6
2-2	Calculated Years of Consistent Rainfall to Fill Bristol Lake	27
3-1	Phase 1, Stage 1 and Phase 2 Strata Coverage	38
3-2	Sample Stage by Site Type	43
3-3	Strata Transects and Sites	44
3-4	Success Ratios by Hierarchical Structuring	47
3-5	Cross-Cutting or Pure Transects by Presence/ Absence of Prehistoric Sites	50
3-6	Stratype to Presence/Absence of Prehistoric Sites	51
3-7	Presence/Absence of Prehistoric Sites to Presence/ Absence of Desert Pavement	52
3-8	Stratype by Presence/Absence of Desert Pavement	54
3-9	Sites By Strata to Desert Pavement	55
3-10	Presence/Absence of Desert Pavement to Presence/ Absence of Prehistoric Sites for Combined Mountain Hill - Valley Bottom and Valley Bottom	57
3-11	Spring/Site Table	59
3-12	Planning Unit Coverage and Return	60
3-13	Stage 2: Distribution of Sites by Subregional Type	67
3-14	Subregional Blocks to Transects and Sites	68
3-15	Subregional Blocks to Presence or Absence of Resources	74
3-16	Sites in Transect to Desert Pavement	75
3-17	Landform Type by Quarter to Presence/Absence of Desert Pavement	78

TABLE OF CONTENTS

LIST OF TABLES (Continued)

Number	Title	Page
3-18	Percent of Desert Pavement by Geologic Deposit	80
4-1	Format for Lake Descriptions	100
4-2	Distributions and Estimated Dates of Lake Sites	103
5-1	Number and Percent of Sites Recorded by Planning Unit and Sample Type	117
5-2	Number of Sites by Site Type and Inventory	118
5-3	Inventory to Number and Percent of Site Types	119
5-4	Subtype to Number and Percent of Lithic Scatter	121
5-5	Number and Types of Pottery by Planning Unit	123
5-6	Comparison of TU/BC/PA to East Mojave Type of Rock Art Sites	126

APPENDICES
(On file with BLM, Riverside)

Letter	Title
A	Contract Requirements
B	Transect to Environmental Variables
C	Archaeological Sites to Environmental Variables and Computer Forms
D	Transect Log and Sample Unit Record Forms
E	Site Log and Site Record Forms
F	Existing Record
G	USGS 15' Maps with Site and Transect Locations
H	Field Log and Select Areas Visited by Dr. Paul Ezell
I	Descriptive Information from Julian D. Hayden
J	Artifact Collection
K	Photo Log
L	Historic Site Data
M	Management
N	Area Figures for Section 5 (Site Patterning Observations)

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---

* Also field-team member.

ABSTRACT

A Class II field inventory to sample approximately 2-1/2 million acres of the California Desert was accomplished under the requirements of Bureau of Land Management Contract YA-512-CT8-163 and is discussed in this report. The actual field survey consisted of one half of one percent of the acreage within the Palen, Bristol-Cadiz and Turtle Mountains Bureau of Land Management Planning Units. A multistage sampling strategy was implemented, a geoarchaeological study of five dry lakes was performed, a purposive historic sites inventory was conducted and a limited pottery collection was made.

Field survey of 168 transects (each 1 mile x 1/8 mile) resulted in the discovery of 75 previously unrecorded cultural resource sites and recordation of 76 cultural resource sites outside of transects. Data from these sites were used to: (1) construct sample survey results overlays; (2) assess environmental variables as factors in predicting human settlement patterns; (3) predict areas of high and low past human activity; (4) project anticipated cultural resource site density and distribution within the study area, and finally, (5) provide a systematic basis for making future planning decisions concerning cultural resource management.

FOREWORD

The Bureau of Land Management (BLM) has been mandated to prepare a desert wide multiple-use plan for the California Desert Conservation Area (25 million acres), in accordance with the purpose and objective of the Federal Land Policy and Management Act of 1976. As part of this effort, the resources (vegetation, wildlife, soils, geology, cultural, etc.) of the California Desert are being located, examined, inventoried and provided with management, directed toward balanced enhancement, preservation, and development or use.

To a large degree, these inventories and the resulting planning decisions are focused on ensuring that cultural, natural, scientific, and aesthetic resources are not endangered nor jeopardized.

This report has been prepared to provide the BLM with Class II, Cultural Resources Field Inventory data relevant to planning efforts in the Turtle Mountains, Bristol/Cadiz and Palen planning units.

SECTION I

INTRODUCTION

By Dennis Gallegos

The Class II Cultural Resource Inventory of the Turtle Mountains, Bristol/Cadiz and Palen Planning Units involved the systematic sampling of 13,440 acres and the purposive inventory of the dry lake/dunes and select historical areas. A Class II inventory identifies, from surface and profile indications, cultural resource sites within a portion of a larger sample universe. The sample universe for this project was 2½-million acres located in both Riverside and San Bernardino counties.

The three planning units for this study were bounded by Joshua Tree National Monument on the west, by Needles and Highway 95 on the east, by Interstate 40 on the north, and by Interstate 10 on the south (see Figure 1-1). The study area includes portions of both the Mojave and Colorado Deserts, a number of mountain ranges (rarely exceeding 4000 feet), broad valleys, and five dry lakes.

The magnitude of the project is exemplified by the fact that 168 transects (1/8 x 1 mile) were inventoried to provide a ½ of 1 percent coverage of the 2½-million acres. The logistics of surveying 168 transects in over 2½-million acres resembled military maneuvers including the use of jeeps, a helicopter, a three-wheeled dune vehicle and a constantly moving field camp. The sample inventory was augmented by utilizing the existing records (previously recorded sites), reviewing historical and prehistorical literature, and visiting select areas (purposive inventory).

A Class I inventory, generally used to provide information on the history and prehistory of a study area prior to a Class II survey, was not available when this Class II inventory commenced; therefore, this report may reflect some duplication of effort.

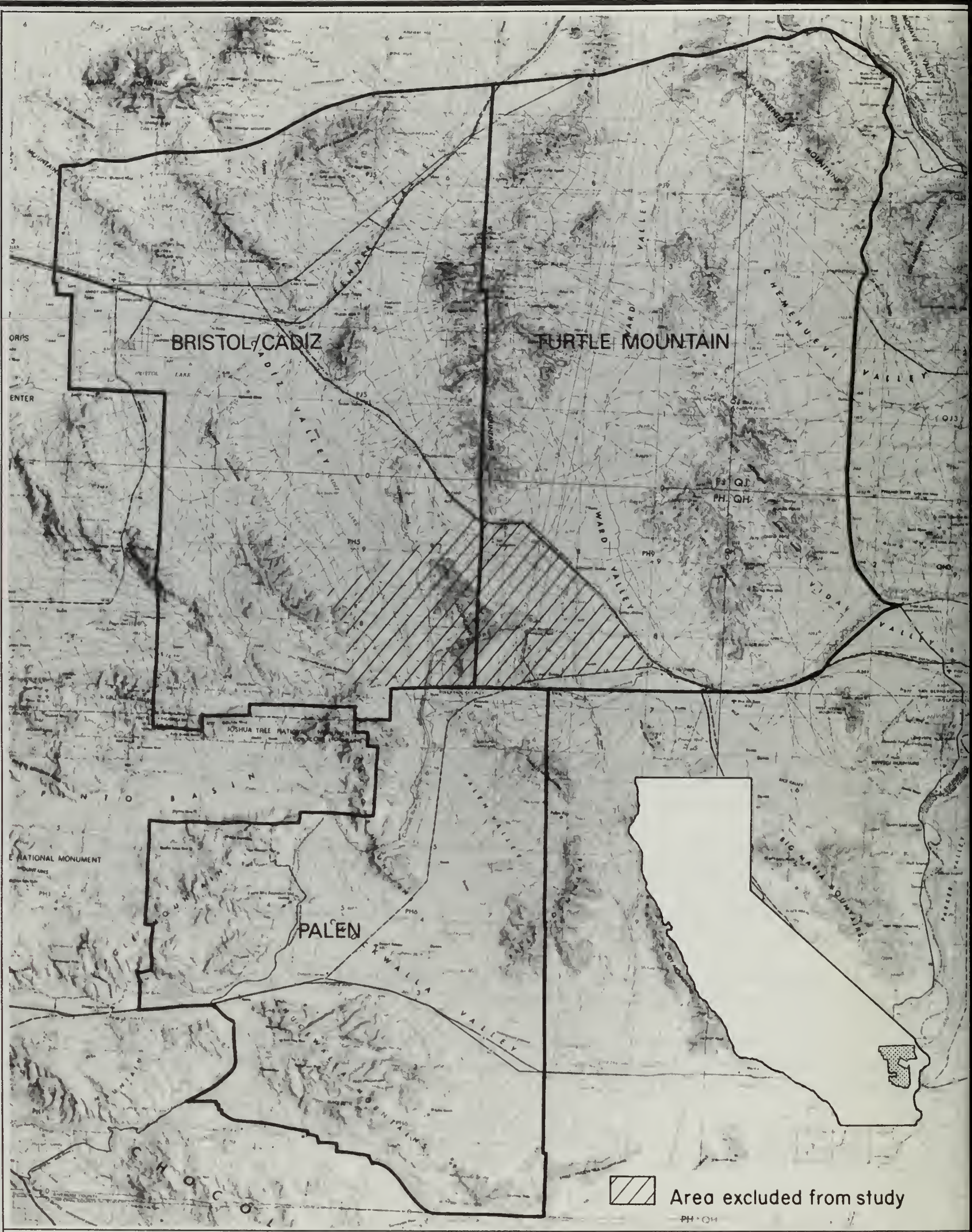
The sampling strategy was based primarily on Margaret Weide's objectives and assumptions (1973) developed for the overall BLM cultural resource inventory of the 16-million acre California Desert Conservation Area.

Three phases of inventory were used in this study. Phase 1 involved systematic sampling based on geomorphology, vegetation and water resource variables. Phase 2 sampling, based on Phase 1 results, investigated certain variables for the location and prediction of archaeological sites. Phase 3 was a purposive inventory of Bristol, Cadiz, Dale, Hayfield and Palen dry lakes.

Numerous statistical data analyses were employed to interpret the Phase 1 and Phase 2 data presented in the results section.

The historical inventory for this report was prepared by using the three phases detailed above, along with library research, personal contacts, and a purposive field inventory of select historic sites.

The purposive inventories augmented the sampling for historic sites and dry lake/dune situations.



Map of study area - Turtle Mountain, Bristol/Cadiz, and Palen Planning Units

FIGURE 1-1

Results from the cultural resource inventory reflect relative site density, area site projections, correlations with environmental variables, and the application of paleoenvironments to site correlations.

The Class II inventory report is designed as a management tool for the prediction and location of sensitive areas. This report, when properly used, can assure that appropriate management considerations are made prior to the implementation of projects which could adversely affect cultural resources.

SECTION II

ENVIRONMENTAL SETTING

By Gary Lowe, Jay Thesken and Dr. Emma Lou Davis

The archaeology of desert basins and ranges can best be understood as one of the numerous expressions of environment and drastic environmental change. This section is intended to create a picture of the study area. To comprehend the size of the task, imagine the acreage of a city park then multiply it by 500,000 times so that it disappears beyond a circle of earth. The total study area for this inventory covers two-and-one-half million acres. It is a desert, one of the last of the silent places on earth. An aerial overview shows a series of mountain ridges with broad valleys which form basins. Circling one of the larger basins in a plane provides visual proof of the simple but fascinating relationship between available rainwater and the various parts of this landscape. First, the basin is a living record of natural actions, both past and present; here, the body of the earth is as alive as the body of an animal. It also is born and dies bit by bit. Tectonic forces expressed by earthquake and volcano have built the mountains surrounding the shallow basin; counter forces of rainwater and wind break down the mountains and pieces are washed onto broad alluvial fans so that the growing, uplifting mountain ranges stand knee-deep in their own rubble. It is a view of a part of nature as alive as people, but with a far longer life span.

The mountain fans can be seen to emerge from steep-walled canyons where rainwater sometimes rushes in torrents, carrying everything in it. At the canyon mouth the torrent slows, loses its wild strength and deposits its load of rock, gravel and sand over a fan or bajada (a sloping, triangular shaped surface of ground). A fan belongs to the canyon that creates it and is sometimes named for this canyon — like the famous Emigrant Fan in Death Valley. Seen from aloft, many fans appear to have been built in sections, visible as slightly different colors, elevations and textures. The sections represent different-age events in the fan's active life, enabling geologists to date its growth.

Another striking feature of this bajada section from an aerial view is the system of drainage channels that cut the earth. Drainages are kept alive by heavy rain. The channels appear as arteries connecting the mountains with a catchment basin in the valley center. Today, during the current cycle of warm-dry climate, this basin is a dry playa surrounded by sand dunes. However, there have been many times in the valley's past history when the catchment basin contained water. The California climate has gone through cycles of weather very different from the present — even hotter and dryer, then cold/dry and cool/moist. Someday these cycles may be repeated again so that shoreline marshes, fresh water ponds, broad expanses of brackish water will again be filled (Davis 1978). Climatic cycles influenced the lives of people dramatically, changing their life style and the places in which they could live.

2.1 Geomorphology/Geology

The study area is characterized by broad alluvial fans, extensive basins (dry lake beds) and northwest/southeast trending mountain ranges. The major mountain ranges are the Chuckwalla, Eagle, Old Woman, Sacramento and Turtle. These mountain ranges are over 90 square miles in size, while numerous smaller ranges are, for the most part, less than 40 square miles (see Table 2-1). The majority of all the mountain ranges are between 1000 and 4000 feet in elevation with only the Old Woman Mountain range rising to over 5000 feet.

The geology of the study area is generally divided into (1) pre-Cenozoic and (2) Cenozoic rock units. Pre-Cenozoic units are composed primarily of Precambrian gneisses and schists covered by late Precambrian and Paleozoic sediments that were subsequently invaded by intrusive and extrusive igneous rocks. The intrusive granitics as such make up a major portion of the pre-Cenozoic rocks of the Mojave Desert. The Cenozoic complex overlies the pre-Cenozoic and is primarily composed of sedimentary and volcanic rock. Basalts and alluvial/lacustrine sediments, as well as some metallic mineral deposits are included within these complexes (Dibblee and Hewett 1966).

2.2 Springs and Seeps

The lack of available water has always posed a serious obstacle to the development or use of desert areas. Aboriginal inhabitants with their limited technological resources were particularly vulnerable to the whimsical nature of the environment. The supply of water is directly dependent on climatic trends. Water was available to the indigenous population from sources ranging from the almost instantaneous and transient runoff resulting from a summer storm to the seemingly steady supply of a long revered spring.

Water is scarce in arid areas, away from major rivers which intrude from faraway on their way to the sea. The study area encompasses a particularly harsh environment. The number of known natural watering places available is small, presently numbering 32 in the 4000-square-mile area. Several very unreliable water holes and natural tanks may exist in local drainages after heavy runoff, but these have not been recorded in the published record.

Because of the harsh conditions in this area, sources of water became of utmost importance to local populations. Human activity of necessity has made repeated contact with springs and seeps in most of the ranges. This activity began with the discovery of the spring, probably in the less harsh conditions of the Wisconsin Pleistocene and has continued nearly uninterrupted to the present.

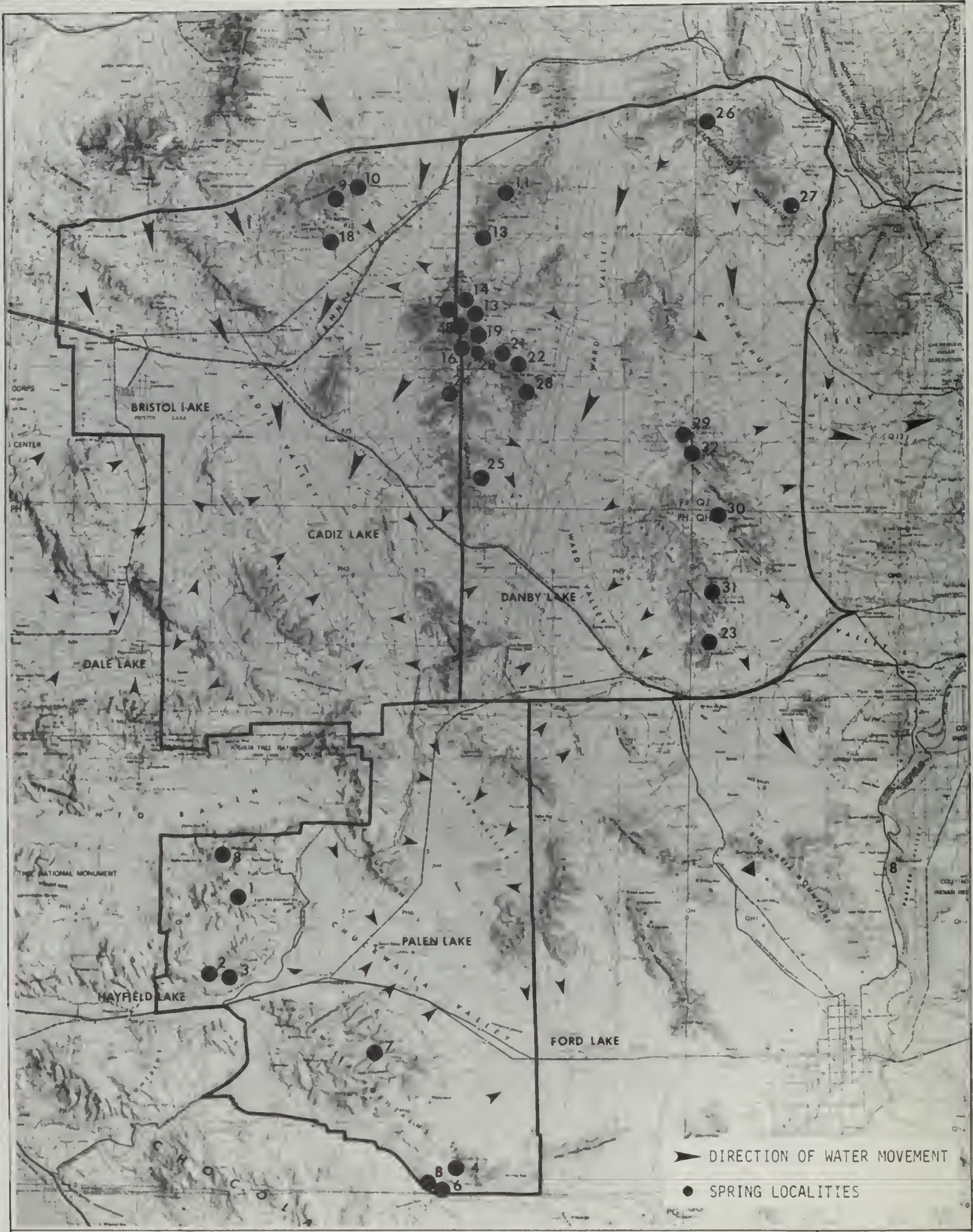
These springs (see Figure 2-1 and Table 2-1) provide at a minimum the location of the late period hubs of human occupance of the study area.

Table 2-1

MOUNTAIN VARIABLES

Mountain Range	Size in sq. mi.	Elevation Range	*Generalized Composition in % M	PE	G	TV	Other	# of springs
Bristol	27	800-3422	15	30	40		15	0
Calumet	40	1000-3004	5	10	80	1	4	0
Chuckwalla	139	1200-4504		35	35	20	10	4
Clipper	38	2000-4604		28		70	2	3
Coxcomb	30	1200-3162	40		60			0
Eagle	98	1600-3969	8	38	50	2	2	4
Granite	25	1600-4353			100		0	
Marble	35	1000-3842			20	60	20	0
Old Woman	96	1000-5090		50	30	10	10	12
Palen	20	800-3438	98			1	1	0
Piute	23	2400-4165		80	5	5	10	2
Sacramento	71	1100-3314		65		25	10	2
Sheephole	15	2000-4114	60		40			0
Ship	15	950-3239			70	30		0
Stepladder	20	1800-2683		25	55	20		0
Turtle	117	1600-4231		58	2	40		5

*M = Precretaceous (metamorphic/meta sedimentary)
PE = Precambrian
G = Granitic
TV = Tertiary Volcanic



Hydrological pattern of water flow and spring locations. Springs numbered 3, 8, 13, 18, 23, and 28 were sampled.

FIGURE 2-1

2.3 Vegetation

The dry landscape of southern California's deserts is a remnant and successor of a lush Pleistocene age that existed more than 20,000 years ago (Parish 1930).

Harsh climatic conditions and a variety of rugged landforms of today's deserts have directed the evolution of specific survival mechanisms within its plant species. Because of the plant's specificity to habitat and the scarcity of water, leading to generally slow growth rates, the "hardy" plants of the desert are actually extremely vulnerable to the slightest habitat change.

Many geomorphological and climatic factors have created numerous localized habitats as well as large, generalized habitats or zones within the desert. Since vegetation, climate and geomorphology are interrelated, zones within the desert can be defined by each of these contributing factors. Most students of the desert such as S. B. Parish, P. A. Munz, E. C. Jaeger, and H. B. Johnson recognize two distinct regions of the southern California desert, the Mojave Desert and the Colorado Desert (Johnson 1976; Munz 1974).

Geographically, both deserts lie east of the southern coastal mountain ranges and the Sierra Nevada range and extend, for our purposes, to the southern and eastern borders of the state of California. The Colorado Desert, which is sometimes referred to as the "low desert," is south of the Mojave or "high" desert (Parish 1930). Geographic division of the two deserts is generally accepted to be the Chuckwalla Mountains in the western portion of the desert. Delineation of deserts east of the Chuckwallas is less discernible due to a lack of abrupt geographical boundaries. Floristically, it can be said that the eastern portion of the Mojave-Colorado Desert border is a broad and nondistinct transitional zone.

Parish (1930) and Munz (1962) have described in some detail the differences between the Mojave and Colorado Deserts. Briefly, the Mojave Desert is, on an average, 2000 feet higher than the Colorado Desert, therefore it receives more rain and experiences colder winters. The Mojave is comprised of many basins and dry, inland lake beds. One large basin system, the Salton or Cahuilla Basin, which was prehistorically an extension of the Gulf of California, constitutes the Colorado Desert. Abrupt natural barriers exist between parts of the Mojave-Colorado Deserts, but not so for other adjacent desert areas. To the northeast of the Mojave Desert, the Great Basin has no barrier, hence these two deserts share many characteristics. Likewise, the Colorado Desert and the Sonoran Desert to the southeast exhibit similarities, including floristic affinities.

The project area is primarily within the defined Mojave Desert area, and extends south to the southern slopes of the Chuckwalla Mountains. Observations of transitional floristic trends between the two deserts can be observed from the southern border of the study area north into the Eagle Mountains and Palen Dry Lake catchment.

Throughout the archaeological reconnaissance of the project area major plant species were noted. Of the plant species noted, five "indicator" plant species, detecting the transition between the Colorado and Mojave Deserts, were determined. Unilaterally, these "indicator species" were noted in some abundance in the northern edge of the Colorado Desert, decreasing in occurrence and eventually ending their range farther to the north.

Palo verde (Cercidium floridum), ironwood (Olneya tesota), desert willow (Chilopsis linearis), honey mesquite (Prosopis glandulosa) and jojoba (Simmondsia chinensis) appeared in abundance immediately south of the Chuckwalla Mountains. Desert willow was not recorded north of this location during the course of this study. Developed stands of palo verde-ironwood were found not to exist north of Chuckwalla Valley with the exception of Vidal Valley near the town of Vidal Junction. Palo verde and ironwood were found to exist in major drainages further to the north, but on a restricted basis. The most northern recording of mesquite was adjacent to Palen Dry Lake. Jojoba was found only directly adjacent to the Chuckwalla Mountains and in the Eagle Mountain catchment near Big Wash.

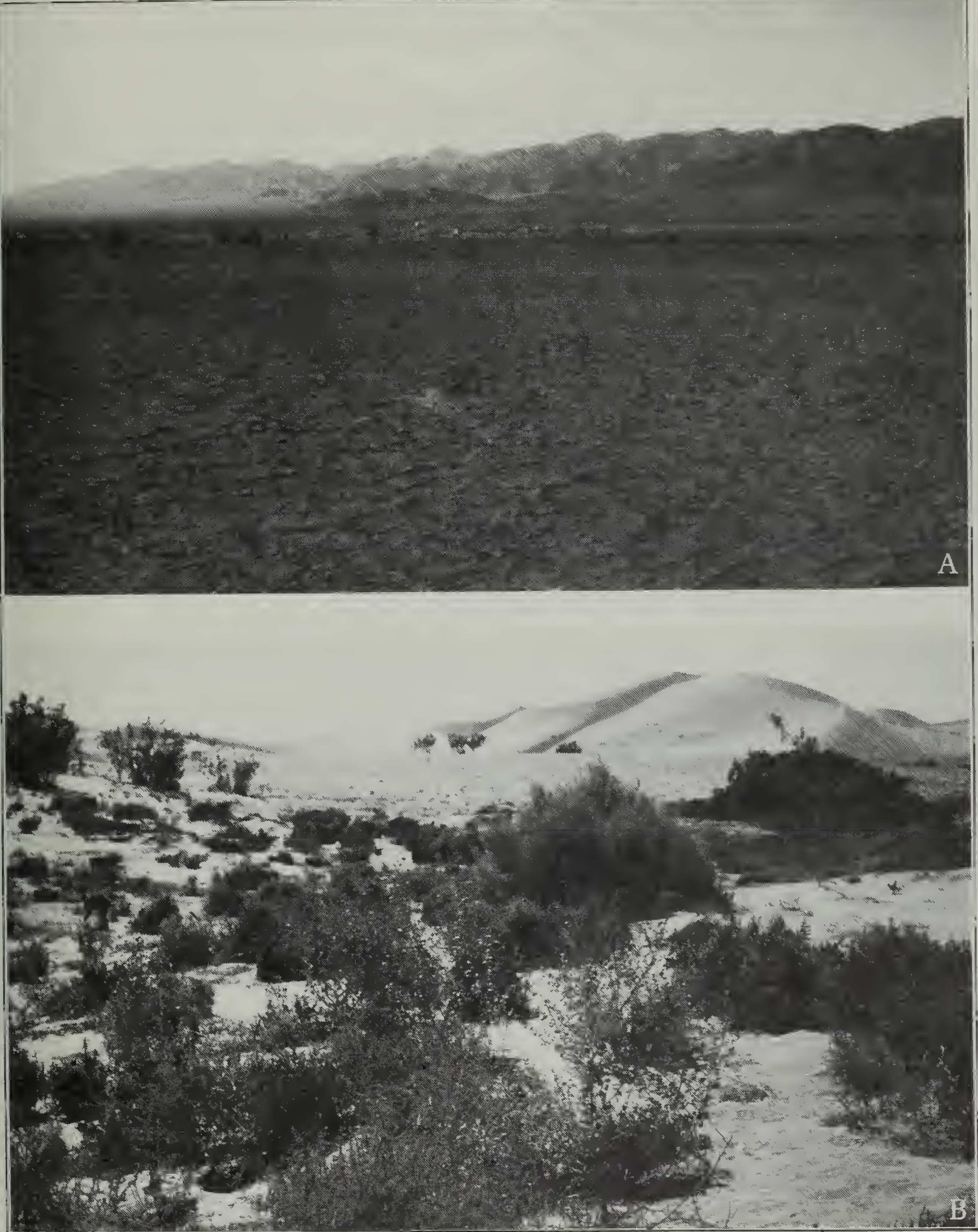
2.3.1 Plant Communities

As discussed earlier, the desert is comprised of a wide variety of landforms. These factors directly influence and/or determine the evolution and range of plant species. Outwardly, a specific habitat may exhibit one or more attributes. A "plant community" is a regional element of the vegetation that is characterized by the presence of certain dominant species. The naming of a plant community often reflects one of its habitat attributes, based either on taxonomic units, plant structural units or in the physical habitat (Johnson 1976). Generally, the system of classifying plant communities used here is an adaptation of Thorne's (1976:1-31) classification system. A similar plant community system is utilized by the United States Department of Interior, BLM Desert Planning Staff. The following discussion of plant communities reflects field observations of the various floral constitutents and physical habitat of the area surveyed.

- Barren - As the name implies, barren areas are, or are virtually, devoid of all plants. The few areas with an absence of plants that were noted occurred on dry lake beds, or on rugged rock areas (see Figure 2-2a).

- Saltbush Scrub - This community occurs in closed water catchments near or on dry lake beds, within dunes or within lava basins. These sandy, alkaline areas support various species of the genus Atriplex (saltbush, desert holly and shadscale), pickleweed (Allenrolfea occidentalis) and Russian thistle (Salsola iberica).

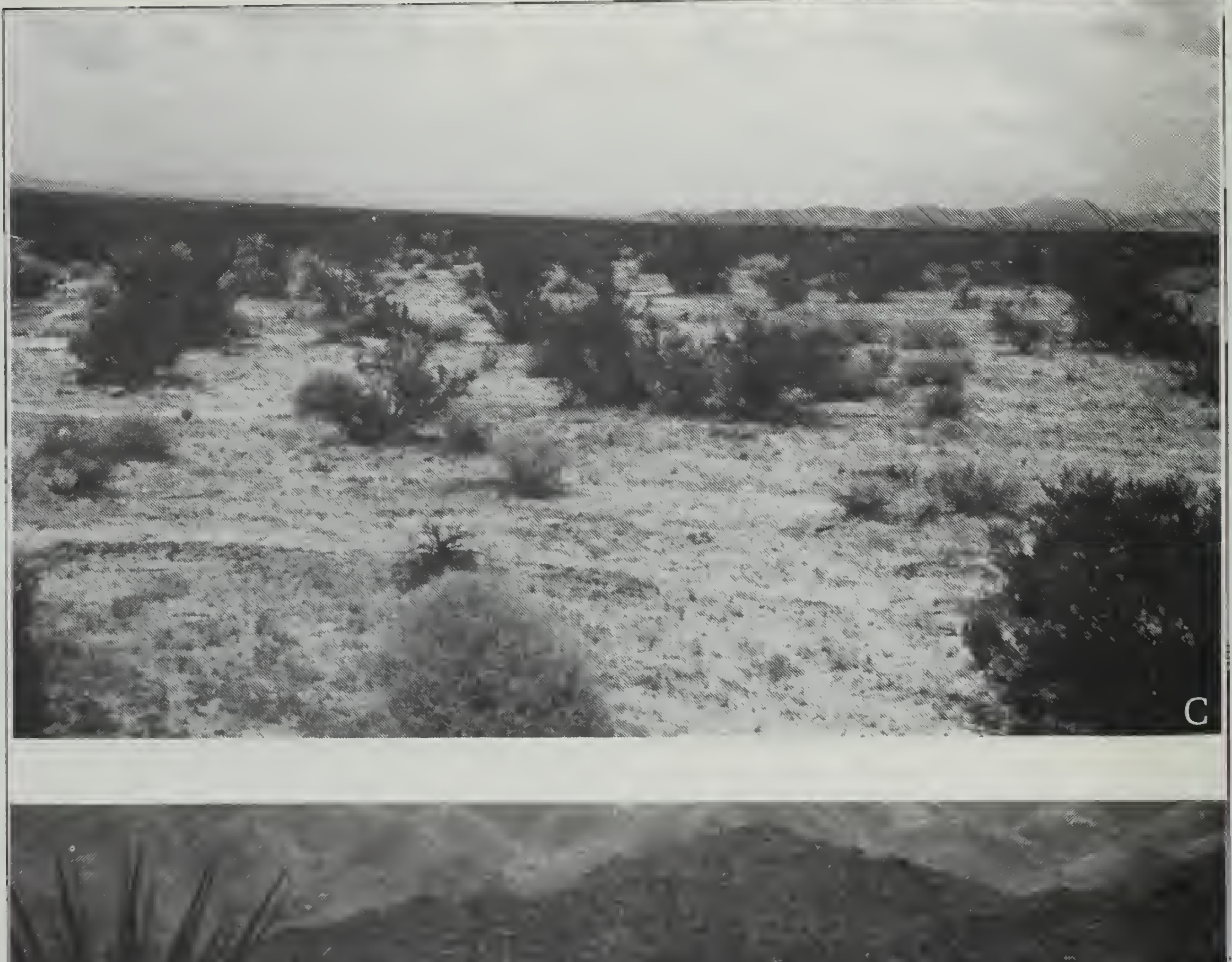
- Dune Scrub - Located within sand hills, stabilized dunes and more restrictively within active dunes, this psammophytic community consists of desert buckwheat (Eriogonum deserticola), desert holly (Atriplex hymenelytra), desert dicoria (Dicoria canescens), creosote bush (Larrea tridentata), Russian thistle (Salsola iberica) and pickleweed (Allenrolfea occidentalis) (see Figure 2-2b).



a. Barren - Bristol Dry Lake with Amboy and Bristol Mountains in background

b. Dune Scrub - Northeast Lake Cadiz (note the new forming dunes in background with no vegetation)

FIGURE 2-2a,b



c. Creosote Bush Scrub - Creosote and Burro Bush
on Alluvial Fan, Valley Bottom Area
d. Yucca/Cactus Scrub - Turtle Mountains Catchment,
Vidal Valley (note pencil cholla and yucca)

FIGURE
2-2c,d

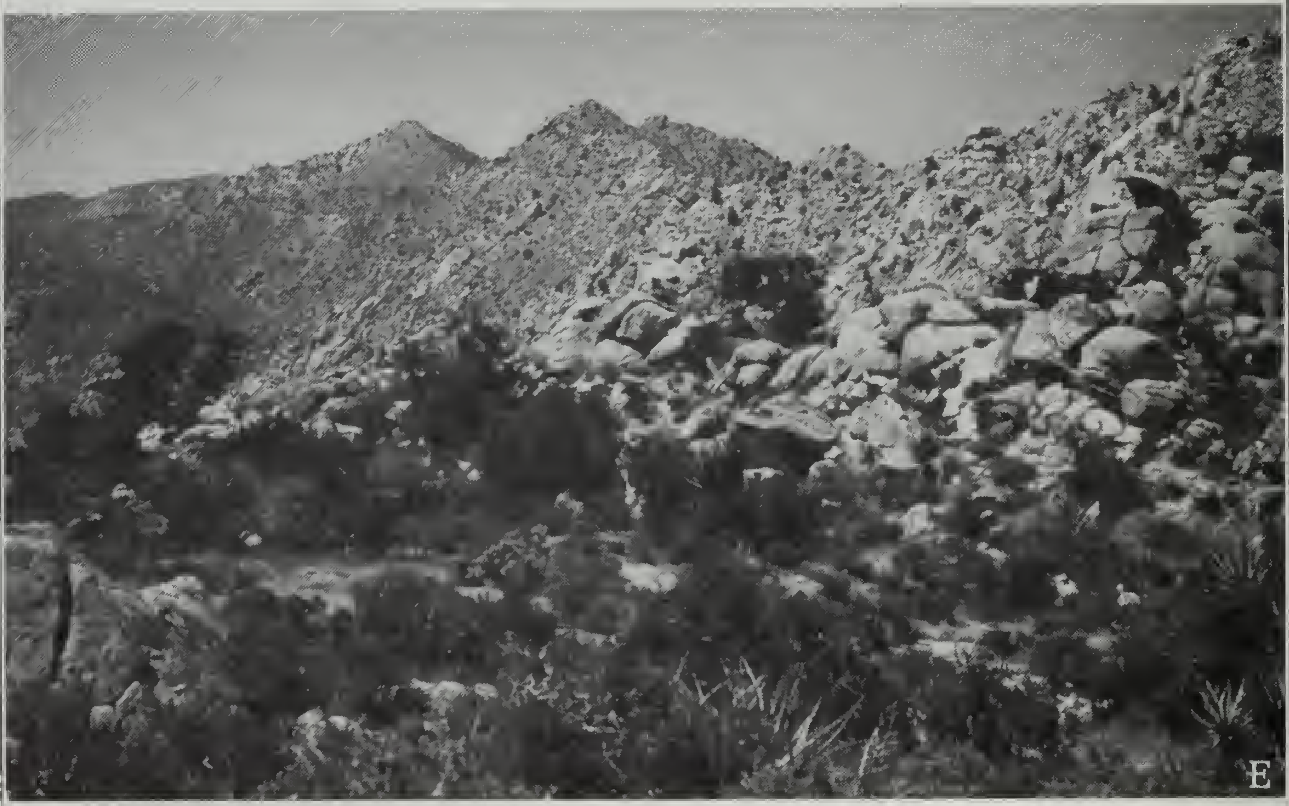
- Creosote Bush Scrub - The most common transmontane plant community is creosote bush scrub, covering alluvium and alluvial valley bottoms. Usually this community is dominated by creosote bush (Larrea tridentata) with brittle bush (Encelia farinosa) and burrobush (Ambrosia dumosa). On mountain slopes, where a sparse representation of this community may occur, brittle bush is often the dominant species. Survey data reflects the prevalence of creosote bush scrub over the desert landscape. Seventy percent of all surveyed transects had this community present as either dominant or subdominant (see Figure 2-2c).

- Cactus Scrub - This spinescent community inhabits well-drained sandy to rocky slopes, bajadas and broad drainage areas. Lacking the less succulent members of the yucca/cactus community such as yucca and ocotillo, this community is dominated by pencil cholla (Opuntia ramosissima), beavertail cactus (Opuntia basilaris), silver cholla (Opuntia echinocarpa), barrel cactus (Ferocactus acanthodes), hedgehog cactus (Echinocereus engelmannii) and foxtail cactus (Mammillaria alversonii).

- Yucca/Cactus Scrub - Located on sandy to rocky slopes, bajadas and intermontane valleys, this floral community is generally found at lower elevations and/or lower within a drainage system than the similar cactus scrub community. Two determining members of this commmunity are Mojave yucca (Yucca schidigera) and ocotillo (Fouquieria splendens). Other constitutents are buckhorn cholla (Opuntia acanthocarpa), jumping cholla (Opuntia bigelovii), pencil cholla (Opuntia ramosissima), beavertail cactus (Opuntia basilaris), barrel cactus (Ferocactus acanthodes) and hedgehog cactus (Echinocereus engelmannii) (see Figure 2-2d).

- Major Wash Woodland - This floral community encompasses the generally recognized Palo Verde/Ironwood or desert microphyll woodland community, but is somewhat broader in geographic distribution. Low, broad and gradual drainages within the Colorado-Mojave transitional zone in the southern portion of the project area provide a habitat for relatively dense populations of palo verde (Cercidium floridum) and ironwood (Olneya tesota). Among the palo verde and ironwood, smaller shrubs such as smoke tree (Dalea spinosa), catclaw (Acacia greggii) and desert lavender (Hyptis emoryi) are also represented. The broad, dense populations of this community generally become minimized further north in the Mojave Desert; here, the community exists within major yet relatively narrow drainage paths. In such cases, the relative occurrence of the smaller shrubs such as catclaw increases.

- Minor Wash Woodland - A primary distinction between the major wash woodland and minor wash woodland communities is that the latter inhabits smaller, narrower washes and gullies, usually positioned higher within a



e. Pinyon/Juniper Woodland - North end of Old Woman Mountains (note pinyon, juniper, yucca, and cactus present near highest portion of Old Woman Mountains).

FIGURE 2-2e

drainage system than the major wash woodland flora. Dominant mesophytic members of this community are catclaw (Acacia greggii), smoke tree (Dalea spinosa), desert lavender (Hyptis emoryi), calabazilla (Cucurbita foetidissima) and cheese bush (Hymenoclea salsola). Other plants found in association with the dominant species are creosote bush (Larrea tridentata), desert trumpet (Eriogonum inflatum), brittle bush (Encelia farinosa) and barrel cactus (Ferocactus acanthodes).

- Pinyon/Juniper Woodland - This upper montane community is represented within the project area on a limited scale. Pinyon pine (Pinus monophylla) and California juniper (Juniperus californica) were found in sparse populations on high slopes and ridges of the Old Woman Mountains. During random surveys of the Turtle and Clipper Mountains, this community was observed. Subdominant members of this community include various species of cactus and Mojave yucca (Yucca schidigera) (see Figure 2-2e).

- Oasis/Spring Woodland - Based primarily on the existence of a permanent water supply, this community is defined here to apply to a variety of hydrophytic populations. Thorne's (1976) definition of an oasis community would exclude most of the small or annual spring communities found within this study area. Only one of the eight springs that were surveyed exhibited a true "oasis" floral population. At Mopah Springs the vegetation included fan palms (Washingtonia filifera) and various grasses. At the other spring habitats, abrupt transition from the surrounding xerophytic condition was also apparent. Some of the plant species found at these locations were jimson weed (Datura meteloides), squaw bush (Rhus trilobata) and cat-tails (Typha sp.).

2.3.2 Ethnobotany

Native Americans, settlers and travelers of the harsh desert environment exploited the natural surroundings with great efficiency. Plants were undoubtedly utilized by the various cultural groups of the California desert for food, medicine, clothing, shelter, ornamentation or ceremonies. The following ethnobotanical descriptions are not limited to the recorded information of the Chemehuevi, Mojave, Serrano and Cahuilla peoples of the project area. Desert plant uses recorded from neighboring native groups and by historic settlers are incorporated here to give a more thorough cultural plant usage description. The plant species listed represent only those that were recorded during this survey project, and may exclude culturally important plants, such as agave, which were not encountered by the survey team.

Acacia greggii - Catclaw

Seed pods were harvested between May and August. The pods ,which were not a favored food source, were either eaten fresh or ground into a flour. Wood from the catclaw was used for both construction and firewood (Bean and Saubel 1972).

Asclepias erosa - Milkweed

Natives extracted the milky sap, let it solidify and chewed it as a gum (Bean and Saubel 1972; Balls 1962). Greens from the plant were collected (May to June), boiled and eaten. Strong fibers from the stems were made into a cordage used to construct snares, slings and nets (Balls 1962). Medicinally, the milky sap of the milkweed was applied to warts (Jaeger 1969).

Atriplex californica - Saltbush

Large quantities of seeds were gathered between July and September and were ground into flour to make mush and cakes. Natives and early settlers processed the root to produce soap for cleaning woolen fabrics (Bean and Saubel 1972; Balls 1962).

Cercidium floridum - Palo Verde

Between July and August, natives collected, dried and ground the bean pods to make mush or cakes (Bean and Saubel 1972; Jaeger 1969).

Chilopsis linearis - Desert Willow

Dwellings, bows, fruit-gathering sticks, nets and clothing all were made from the wood and bark fibers (Bean and Saubel 1972). Early settlers made fence posts from the wood. Mexicans make a medicinal tea from the dried flowers.

Cucurbita foetidissima - Wild Gourd, Calabazilla, Coyote Melon

As a food source, the seeds were ground into a flour. This plant was used extensively by natives and settlers as a body and laundry soap (Bean and Saubel 1972; Sweet 1962). The pulp and juice from the crushed plant was used as an ointment. Various utensils were made from the hollow, dried gourd.

Dalea spinosa - Smoke Tree, Indigo Bush

Natives made a yellow dye by boiling the flowers of various species of Dalea (Balls 1962; Sweet 1962).

Datura meteloides - Jimson Weed, Toloache

This hallucinogen and medicinal plant has been used by most southern California native groups. Ceremonially, the hallucinogenic properties of the plant played an important role in boys' puberty rites and for shamanistic visions (Bean and Saubel 1972; Hedges 1967). Medicinally, a pain-killing paste was produced and applied to broken bones and toothaches.

Encelia farinosa - Encelia, Brittle Bush, Incienso

Resin was both chewed as a gum and used as a pain-relieving ointment for chest pains (Jaeger 1969). A brew from boiling the blossoms, leaves and stems was held in the mouth to deaden the toothache pain.

Ephedra viridis and E. nevadensis - Mormon Tea, Mexican Tea

The twigs to make a beverage and/or medicinal tea were collected in late summer. Natives and early settlers brewed this popular drink (Bean and Saubel 1972). Medicinally, the tea was used for colds and internal disorders. Seeds from the plant were ground and made into cakes (Balls 1962).

Eriogonum fasciculatum - Wild Buckwheat

A tea made from the leaves or the white flowers was a medicine for headaches and stomach disorders. The tea was also given to babies to cure diarrhea (Hedges 1967). Young, edible shoots were collected in the spring (Bean and Saubel 1972).

Ferocactus acanthodes - Barrel Cactus

Buds were eaten either fresh or parboiled, dried and stored. Mature flowers were prepared and eaten in a similar manner (Bean and Saubel 1972). A palatable liquid was derived from the spongy interior of the plant (Balls 1962). Some natives hollowed out the barrel cactus without uprooting it and used it as a temporary cooking pot (Balls 1962). The long, sturdy spines were used as awls and for applying tattoos (Balls 1962).

Fouquieria splendens - Ocotillo

Edible blossoms were eaten or soaked in water to produce a drink (Bean and Saubel 1972). Seeds, extracted from pods, were parched and ground into a flour. Early settlers and Mexicans used the long branches to construct fences. Dried branches were generally used for firewood.

Hyptis emoryi - Desert Lavender

A brew made from the boiled blossoms and leaves was used to stop hemorrhaging by a Cahuilla shaman. The seeds are edible but were not generally exploited by the Indians (Bean and Saubel 1972).

Juniperus californica - California Juniper

Juniper berries were either eaten fresh or dried and stored (Barrows 1971). Dried berries were ground into a flour to make mush or cakes (Jaeger 1969). A tea, brewed either from the berries or the bark, was used by some native groups to cure colds and fever (Bean and Saubel 1972).

Larrea tridentata - Creosote Bush, Covillea

Creosote bush was an important medicinal plant for all of the desert Indian groups (Bean and Saubel 1972; Hedges 1967). Tea was made from the stems and leaves and used to cure colds, digestive disorders, menstrual cramps and other ailments. A poultice made from the leaves and stems was applied to external cuts and infections. Inhaling the steam from boiling creosote bush leaves relieved congestion; aching bones and sprains were bathed in a hot decoction of creosote leaves (Hedges 1967). Early Spaniards in the desert used the medicinal properties of the plant for their horses (Sweet 1962).

Mammillaria tetrancistra - Fishhook Cactus, Corkseed Cactus

The fruit of this plant was eaten raw (Hedges 1967).

Nolina bigelovii - Nolina

The stalks of the nolina were roasted in rock-lined pits and eaten (Bean and Saubel 1972).

Olneya tesota - Desert Ironwood

Natives utilized the seed pods and the wood of this plant (Bean and Saubel 1972; Munz 1962). The pods, collected in early summer, were roasted and ground into flour. Besides being used as a firewood, the hard wood was used to make various implements such as clubs and throwing sticks.

Opuntia acanthocarpa - Buckthorn Cholla

The ripe fruits were either eaten fresh or dried and stored. Medicinally, ashes from burned stems were applied to cuts (Bean and Saubel 1972).

Opuntia basilaris - Beavertail Cactus

In early summer, Indians gathered large quantities of the sweet fruit which were eaten raw, cooked or steamed. Some of the cooked fruits were dried and stored. Large seeds contained within the fruit, were ground to make a mush (Bean and Saubel 1972). The young flower buds and joints were also cooked and eaten.

Opuntia bigelovii - Jumping Cholla, Teddybear Cholla

The buds were collected, cooked and eaten in a similar fashion to O. basilaris.

Opuntia echinocarpa - Silver Cholla, Golden Cholla

The silver cholla buds were collected and eaten like O. basilaris and O. bigelovii.

Opuntia mojavensis - Mojave Prickly Pear Cactus

Cooked fruits and pods were eaten by natives; the fruits were also often eaten raw. Spines were utilized as tattoo needles (Hedges 1967). Mexicans and other early settlers boiled the plant to provide steam to relieve asthma. A thick juice extracted from the cooked plant was used to lubricate oxcart wheels (Hedges 1967).

Opuntia ramosissima - Pencil Cholla

The fruits, buds and joints were edible. Fruits and joints could be cooked, dried and stored (Bean and Saubel 1972).

Phoradendron californicum - Mistletoe

Berries were ground, boiled and eaten. A black dye made by boiling the mistletoe plant, was used in basket-making. A tea made from the dried plant was used for medicinal purposes and to treat dandruff (Hedges 1967). A mixture of mud and crushed mistletoe was used to rid the hair of vermin (Hedges 1967).

Pinus monophylla - Pinyon Pine

Within its limited desert distribution, this was an important food source for the Indians. The cones were harvested and then the pinyon nuts were extracted. Sometimes the cones were put into a roasting pit until the nuts could easily be removed. The nuts were eaten whole or ground and made into a mush or a beverage. Needles were used as a basket-making material. Pitch from the pinyon pine provided an excellent adhesive for mending pottery and baskets and for fastening projectile points to arrow shafts (Bean and Saubel 1972). Ken Hedges (personal communication) suggests that the pitch was an ingredient of pictograph paint. The pitch was also used for internal and external medicinal purposes. Historically, woods such as mesquite, pinyon pine and juniper have been used for heating and for smelting of iron ores.

Prosopis juliflora - Honey Mesquite, Algaroba

This was the primary food plant of most desert Indians. Seed pods were gathered in summer, dried, ground into flour, and made into mush, a beverage or cakes. Wooden mortars were made from mesquite trunks. Mesquite wood was also important in the construction of dwellings, bows, digging sticks and other tools. Gum from the mesquite was used to fasten arrow foreshafts and to attach baskets to mortars. It was also used to produce a black dye, used on pottery and for darkening hair (Balls 1962). A diluted solution made from the gum was useful in treating sores. Historically, various farm implements were made from mesquite wood. The wood was favored by both natives and early settlers as firewood.

Simmondsia chinensis - Jojoba, Goatnut

The seeds were either eaten fresh or ground into a powder to make a beverage (Bean and Saubel 1972). The food potential of the jojoba was exploited by both the natives and Mexicans. Natives used oil from the seeds as a hair tonic (Sweet 1962).

Washingtonia filifera - Fan Palm

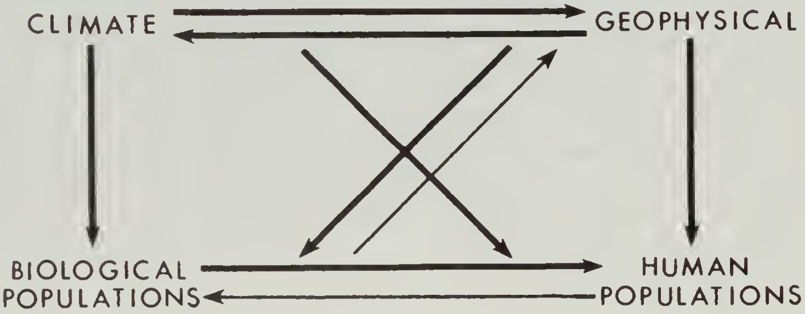
The fruit of the fan palm constituted an important food source for native desert peoples. The fruit, collected in late summer, was either eaten fresh or dried and stored. Dried fruits were ground to make mush, and a beverage was made by soaking the fruit in water. Stems from the fronds were fashioned into utensils such as stirring sticks. The fibrous palm leaves were utilized in the construction of dwellings, baskets, sandals and death-ceremony dolls (Bean and Saubel 1972).

Yucca schidigera - Mojave Yucca

The flower blossoms and young stalks were eaten by desert natives. The root was crushed to produce a juice used as soap, and by pounding the leaves of the yucca. Natives extracted strong fibers to make sandals, bow string, rope, mats and blankets (Bean and Saubel 1972).

2.3.3 Discussion

As in any ecosystem, the desert is a product of climatic, geomorphic and biological processes. This section has dealt primarily with the biological process and, more specifically, the current botanical manifestation of this inter dependent process. There is a basic bilateral relationship between climatic and geomorphic forces. Weather is a prime determinant of the desert's physical landscape, and conversely, the landscape is a determinant of the weather. Interaction of these two forces provides biological populations with a physical habitat. Specific geomorphic habitats, including factors such as water, soil, slope, elevation, wind and drainage, guide the evolution and succession of plant populations. The discussion of plant communities within this section defines the recognized geomorphic habitat and the plant species that presently occur in response to the habitat. A visualization of the determining forces within the desert ecosystem (more specifically, the project area) in its natural and aboriginal state, showing relative determination, is presented below:



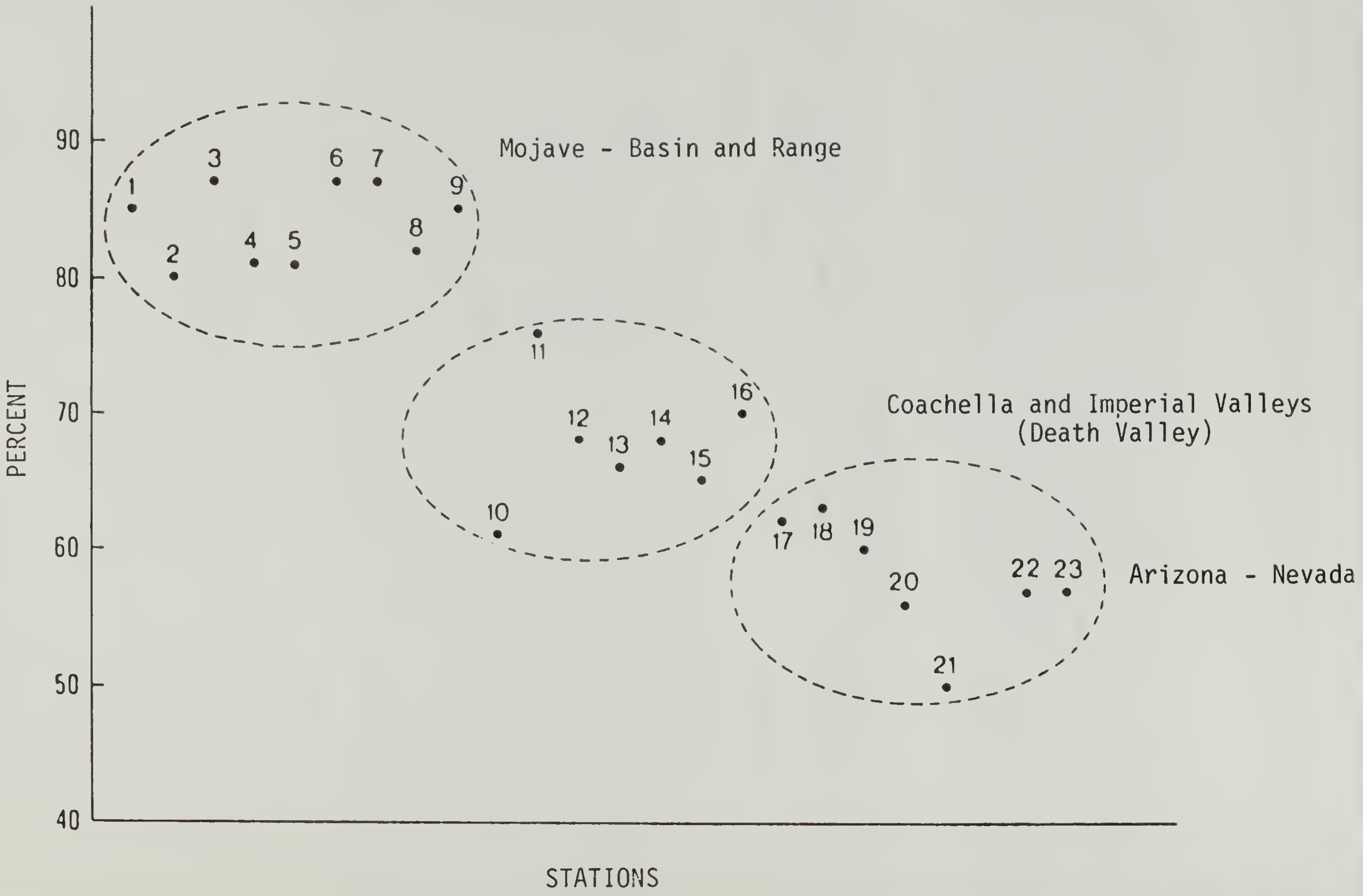
One purpose of the project was to record and project the occurrence of cultural sites. As shown by the ethnobotanical discussion, plants were essential to aboriginal life but the presence of culturally useful plants is only one determining factor of human activity locations.

2.4 Climate

The stations represented on Figure 2-3 cluster according to winter precipitation characteristics. Most stations located in the Mojave Basin and Range (essentially the western Mojave) have the highest percentage of winter precipitation (frontal activity). The Coachella, Imperial, and Death Valleys receive less winter precipitation and more summer precipitation than the Mojave Basin and Range stations. Moist tropical air from the Gulfs of California and Mexico affects these locations, although not to the degree of stations located in western Arizona and southwestern Nevada. As one moves eastward across Arizona, summer precipitation becomes even more significant.

STATION INDEX

1. Big Pine
2. Bishop
3. Fairmont
4. Haiwee
5. Independence
6. Palmdale
7. Squirrel Inn
8. Trona
9. Valermo
10. Blythe
11. Boulevard
12. Brawley
13. Death Valley
14. El Centro
15. Imperial
16. Indio
17. Parker, AZ
18. Yuma, AZ
19. Adaven, NV
20. Caliente, NV
21. Mina, NV
22. Boulder City, NV
23. Las Vegas, NV



Percent of precipitation falling during six winter months at selected desert locations (Huning 1978)

FIGURE 2-3

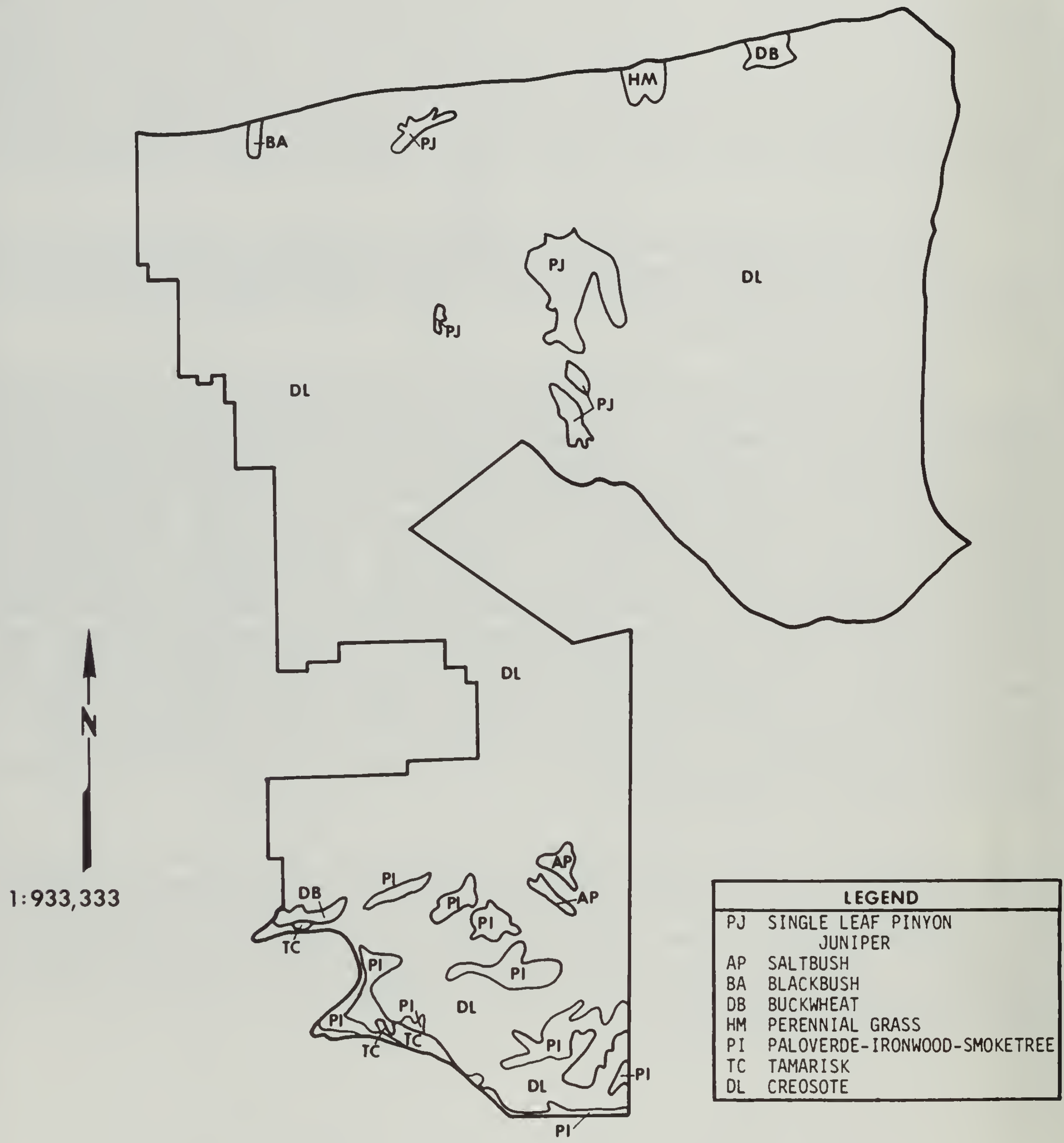
2.5 The Late Pleistocene Environment

Research throughout the Mojave Desert and the southern Great Basin can be used to make general interpretations as to climatic conditions in the study area during post-Sangamon (120,000 B.P.). The nature of the available data provides more thorough information on younger time periods. The writings of Blackwelder (1954), Blackwelder et al. (1936), Davis (1978), and Smith (1968, 1975) set the scene as to the general environmental conditions that could be expected in southeastern California. Studies conducted within the study area which have considerably influenced paleoclimatic interpretations are those of Bassett et al. (1959), Gale (1951), and Wells and Berger (1967).

The desert environment developed following the major tectonic pulse of the mid-Pliocene to early Pleistocene (e.g. Axelrod 1957). After the early Pleistocene, the Mojave Desert increasingly experienced lower rainfall and higher temperatures than lands to the west and northwest.

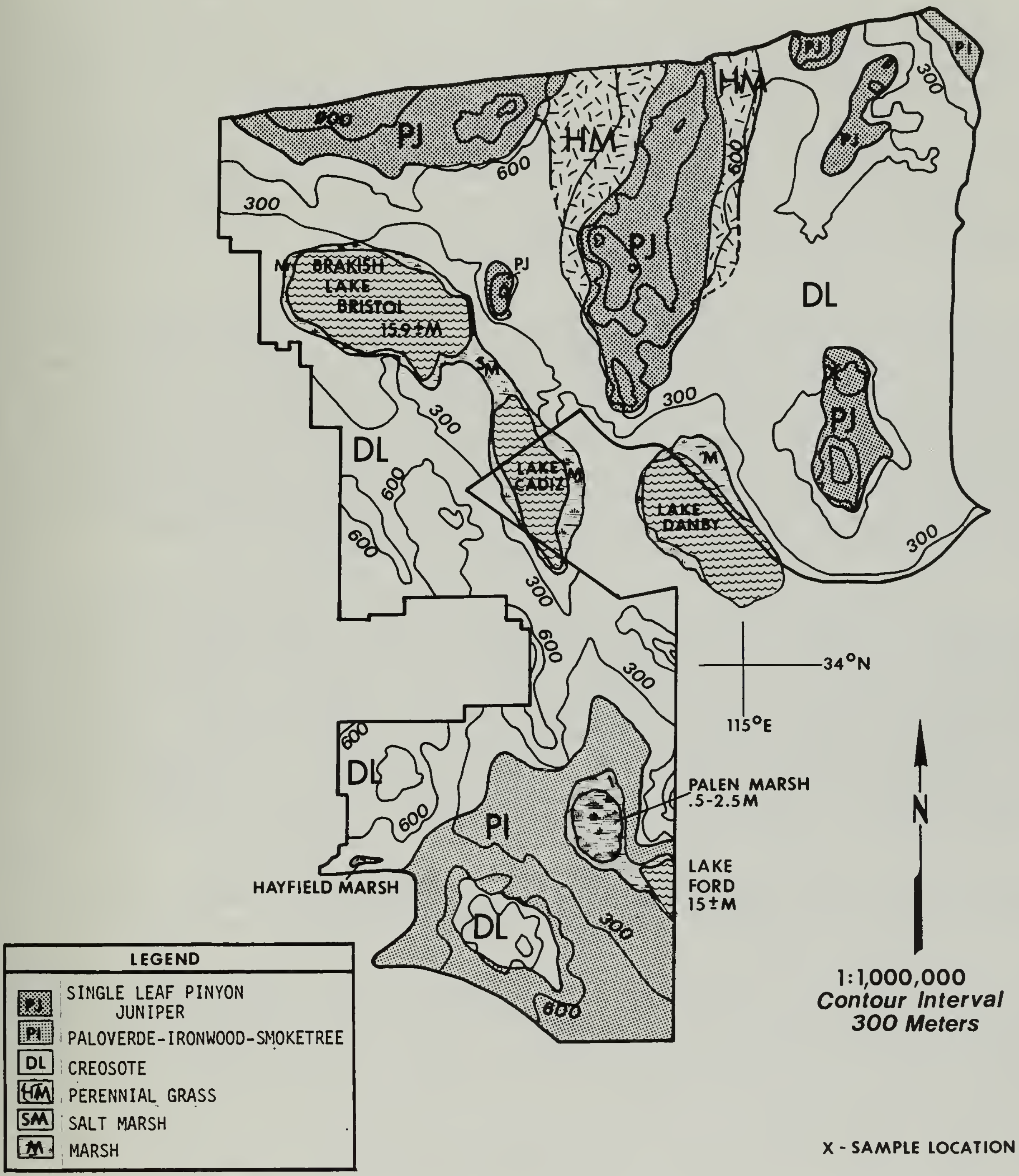
The glacio-pluvial periods interspersed with warm-dry periods during the early Pleistocene represented major alterations of the general climatic trend that had been developing since the Oligocene. The warm-dry periods (represented fairly well by the present environment) presented conditions in which the more drought-tolerant inhabitants expanded their ranges while the more mesic elements retreated. In contrast, the opposite occurred during the relatively cool and moist pluvial periods. Figure 2-4 is an approximate modern vegetation map for the study area and represents an expansion of the more drought-resistant community. Comparison with Figure 2-5 shows that expansion and contraction of plant communities connotes an equally extensive expansion or contraction of favorable human habitats. Figure 2-5 represents an approximate vegetation cover which may have existed during the Tioga glaciation which was occurring at this same time interval (ca. 10,000 to 23,000 BP) in the Sierra Nevada; it is based on wood rat middens from the Turtle Mountains (Wells and Berger 1967) and considerable interpolation. Existence or nonexistence of the lake environment influences the potential for human habitation of the area at least as much as the relative size of the Pinyon-Juniper woodland.

The southern lakes (Bristol, Cadiz and Palen), like those of the Death Valley system (Blanc and Cleveland 1961), have left complex sedimentary records as observed by Davis (see Section 4). Observations, photographs and drawings of dune/paleosol and playa relationships indicate that archaeology can be correlated with lake bed sediment deposition and erosion. These episodes cannot be dated as yet, but, bracket in time the appearance of environments that were ecologically supportative of hunting-gathering people with Stone Age technologies.



Modern vegetation map taken from Calveg Study (USDA, n.d.)

FIGURE 2-4



Map interpolated from wood rat midden analysis (Wells and Berger, 1967)

FIGURE 2-5

2.5.1 Bristol-Cadiz-Danby Lake System

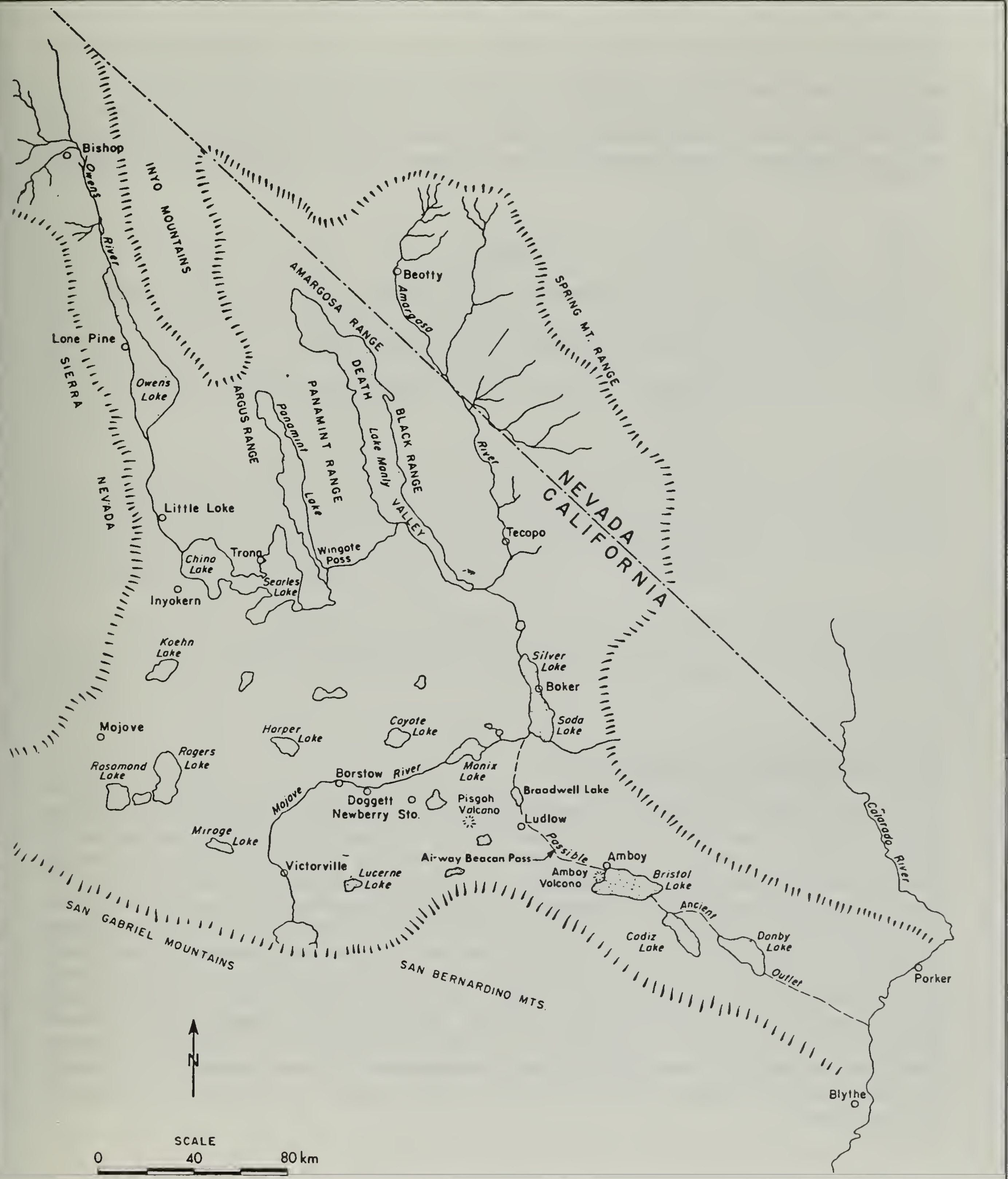
Blanc and Cleveland (1961), unlike Blackwelder (1954), show possible drainage routes (Figure 2-6) of Mojave Desert pluvial lakes at the Sierran Tahoe glaciation stage (43,000-68,000 B.P.). The disparity between the above authors relates to whether or not the Mojave River drains into the Colorado River via Bristol-Cadiz-Danby basins. Figure 2-6 shows a possible channel past Ludlow from Troy and Broadwell Lakes toward Bristol Basin. The current outlet along this route is about 1900 feet above mean sea level (MSL). The highest point on the northward outlet channel is about 1300 ft, discharging toward the area known as Mojave River Wash. From here it is downhill all the way to Soda Lake-Silver Lake (Lake Mojave) and thence downstream via Silurian Valley and Amargosa River to Death Valley (Lake Manly). Thus, modern elevations do not support capture of the Mojave River drainage into Bristol-Cadiz Valley.

The 1900 foot pass (Airway Beacon Pass T7N, R8E, Sec 21, San Bernardino 1:250,000 sheet) is underlain by older Pleistocene nonmarine fanglomerates (Rogers 1967) which are in turn underlain by undifferentiated Tertiary intrusive rhyolites and andesites and various Miocene volcanics. The Pleistocene fanglomerates are probably not very thick, thus precluding a lower pass elevation. The general lack of detailed geologic (small scale) investigations in this region prevents a more precise age assignment to these materials; they are referred to as lower Pleistocene or possibly upper Pliocene. At any rate they are significantly older than the end of the Sangamon, so it can be assumed that no transfer of water from the Mojave River system to the Bristol-Cadiz system has occurred within the last 120,000 years.

Consideration must be given to the possibility of tectonic modification accounting for Mojave River drainage entering the Bristol-Cadiz basins. The total differential elevation between the two potential exits from Broadwell Lake is 600 feet and is even less when the thickness of the lower Pleistocene fanglomerates is considered. No evidence to support the tilting exists in surface outcrops. Subsurface data is likewise lacking, however, tilted strata in drillhole Cadiz 1 (Bassett *et al.* 1959) at a depth below about 250 feet may indicate such tilting even though drillholes Bristol 2 and Danby 1 and 2 show no signs of tilted strata. The authors' (Bassett *et al.* 1959) interpretation of sediment compaction near the lake margin is probably correct.

Water resources of upper Pleistocene (Wisconsin) Lakes Bristol, Cadiz and Danby did not rely on waters originating in the Mojave River drainage basin. No statements are put forward as to occurrences during pre-Wisconsin times.

As a result of the exclusion of the possibility of Mojave River drainage contributing to the Bristol-Danby system, it must be surmised that the lakes received runoff from entirely within the Mojave Desert (see Figure 2). The drainage basins and contributing runoff to the Bristol-Cadiz-Danby system in this investigation are those given by Bassett *et al.* 1959. There are about 10,500 km^2 (4000 square miles) for the Bristol-Cadiz Basin (assumed 7100 km^2 Bristol and 3400 km^2 Cadiz) and 2600 km^2 (1000 mi^2) for the Danby drainage. A late Pleistocene evaporation rate of 1.78 m/yr (Smith 1975) will be assumed for the area. In the existing environment the lakes are typically dry with an average precipitation of 5.79 cm/yr. The amount of precipitation required



Map of Pleistocene lake system (Blackwelder, 1954)

FIGURE 2-6

to maintain moist lake conditions at Bristol Lake (i.e. input = evaporation) would be 13.03 cm/yr assuming that any precipitation in excess of the current amount ends up in the lake basin (i.e. becomes runoff). Therefore, any rainfall in excess of 13.03 cm/yr would cause an increase in lake surface level. If these conditions were to remain for a sufficient length of time Bristol Lake would fill to overflowing, 15.9 meters depth. The number of years required to cause filling of Bristol Lake at constant yearly average rainfall are given in Table 2-2.

Table 2-2

CALCULATED YEARS OF CONSISTENT RAINFALL TO FILL BRISTOL LAKE

(Current 5.79 cm/yr is Dry Lake Baseline)

Rainfall	Years Required
13.03	1525.0
13.08	255.0
13.34	82.4
15.24	35.0
17.78	16.3
20.32	10.6

2.5.2 Rainfall Based on Salt Content

Gale (1951) recognizes many salt lenses at shallow depth within the sediments of Bristol Lake. The largest discrete lens lies near the center of the original basin at a depth of three to seven feet. This deposit is an average of five feet thick and has an areal extent of about 4.75 square miles. This salt body contains in excess of 1.52×10^7 tons of NaCl. Assuming that this salt accumulation represents the sodium chloride derived from the evaporation of Bristol Lake waters during the pluvial maximum (Tioga stage), over a period of 20,000 years, then the resulting average annual rainfall which was contributed to the lake basin would have been 9.70 cm (3.82 in.) assuming 1 ppm NaCl in rain (Foth et al. 1964; Carroll 1962). The waters of the Bristol Lake full stage (52 foot depth) would have contained 3500 ppm (0.353 percent) sodium chloride toward the end of the Tioga stage. Judging by the significant quantity of salt elsewhere in the basin this was probably the minimum salinity throughout the lake's history. Thus Bristol Lake was a brackish lake, drinkable only if no other water was available, and possibly not even then.

Actual rainfall during pluvial maximums may have considerably exceeded those indicated from the quantity of salt contained in a very small portion of the lake basin (1.68 times modern rainfall). However, rainfalls in excess of 2.5 times the current average (i.e. 14.48 cm/yr) are not consistent with proposed vegetational patterns (i.e. maintaining pinyon-juniper woodland without introduction of Jeffery woodland species).

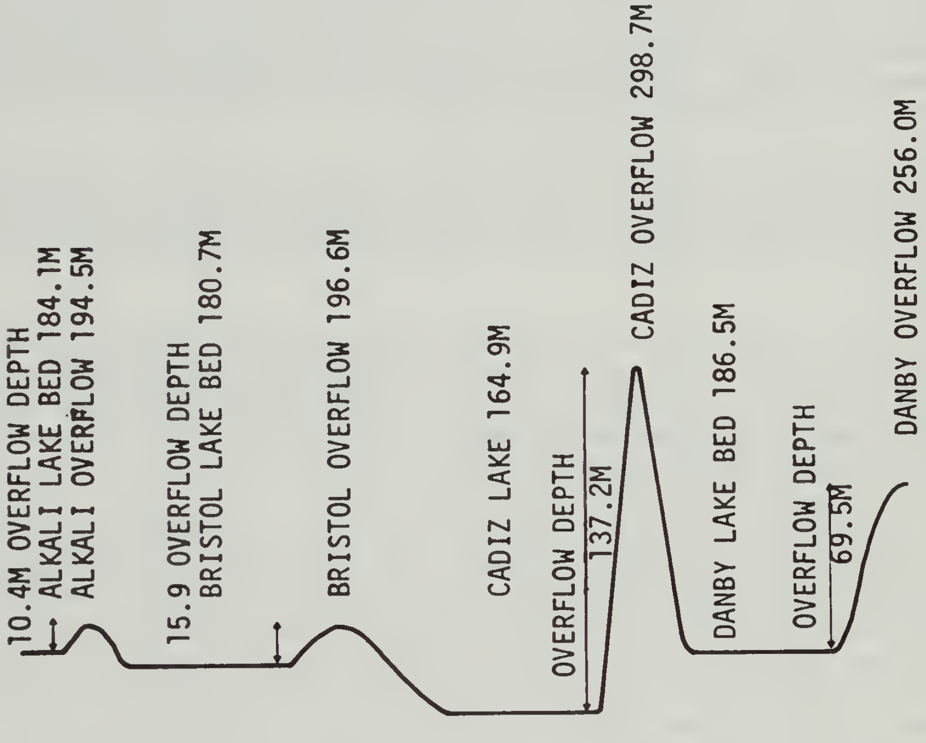
Figure 2-7 is a sectional view of the Bristol to Danby system. The sectional view shows that the extent to which each lake must fill varies considerably. Alkali Lake is a remnant of Bristol Lake separated by the eruption of the Amboy Volcanics about 6000 years B.P. (Parker 1963). The combined Bristol-Cadiz Basin would have to fill up to the 298.7 meter elevation (1980 feet) and would be 137 meters (450 feet) deep before overflowing into Danby Basin. This combined lake would cover 1300 km^2 (500 mi^2) and would require 365 years of consistent 3 fold precipitation to fill. For any given consistent rainfall, Danby Lake would take approximately four times as long as Bristol Lake to fill.

Cadiz Lake thus seldom received overflow from Bristol Lake. The drainage area contributing to Cadiz Lake is only about one-half that of Bristol Lake. Thus, the maximum amount of salt contributed to the basin should likewise be about one-half. No *extensive* mineable deposits are known to occur, but Bassett *et al.* (1959) indicate that *rock salt* is present at depth. Some brine evaporation has been attempted at times, and was ongoing at the time of this investigation (1978).

The Cadiz lakebed is less extensive than Bristol Lake and, even though the drainage basin is smaller, it may have been deeper than Bristol Lake. This implies that the lake may have contained fresher water than Bristol Lake, although it was probably brackish in nature.

Danby Lake receives runoff from about 1000 sq mi of drainage basin most of which is within Ward Valley. Although Ward Valley may have represented a significant groundwater basin during pluvial periods, storing water and lowering the total amount available immediately to the lake, the situation was probably similar to the Cadiz Lake basin. Danby Lake was probably a brackish lake.

Shoreline features at these lakes are rare indeed. Bassett *et al.* (1959:101) explicitly state that no shoreline features, wave cut terraces or gravel bars are associated with Bristol, Cadiz or Danby Dry Lakes. Thompson (1929) traveled through this valley-lake area and reported that he did not find any evidence of a lake in the form of beaches or wave-cut cliffs. In an unpublished report in the files of the United States Geologic Survey relating to Potash investigations, Charles E. Watson states that "about 400 yards north and east from Ward Station (Saltmarsh) there is a marked terrace or shoreline, where a shelf of limy rock (probably caliche) underlies a thick bed of gravel. It appears likely that careful investigation would reveal a definite shoreline."



Alkali, Bristol, Cadiz and Danby overflow system

FIGURE
2-7

The high precipitation necessary to fill these lakes suggests that they were relatively shallow and short lived. Bristol Lake may have occasionally filled to overflowing. However, extensive salt deposits suggest that this lake evaporated and was not a feeder lake to Cadiz Lake (Bassett et al. 1959; Gale 1951). Danby Lake was probably always a discrete entity.

2.5.3 Hayfield-Palen-Ford Lake System

2.5.3.1 Hayfield Lake

The surface of Hayfield Lake varies in elevation from approximately 404 m (1325 ft) to 418 m (1370 ft). The lower elevations are in the western third. The lake bed slopes approximately 0.5 degree to the west indicating that any water would accumulate in the western portion of the lake. The potential outlet was on the east at an elevation of about 421 m (1380 ft). Maximum lake depth would be about 18 m (60 ft). Drainage basin area is about 520 square kilometers (200 mi^2). The lake bed has a surface area of about 6.5 km^2 (2.5 mi^2); the full lake would cover approximately 18 km^2 (7 mi^2).

Hayfield Lake possibly overflowed during the Wisconsin era. The lake could be filled in 7 to 10 years with twice the amount of current rainfall. The overflow would have contributed to Palen Lake.

2.5.3.2 Palen-Ford System

The modern elevation of the floor of Palen Dry Lake is about 129.5 m (425 ft) and the lake bed in sections 26 and 27 is about 127.4 m (418 ft). The highest point between Palen Lake and the lake in sections 26 and 27 is about 132 m (433 ft) which means that Palen Lake would obtain a maximum depth of 2.5 m (8 ft), averaging less than 2 m (6 ft). Ford Dry Lake is about 107.4 m (354 ft) in elevation. The highest point between Ford Lake and the lake in sections 26 and 27 is about 128.3 m (421 ft) which means that the maximum depth of the lake in sections 26 and 27 would be 0.91 m (3 ft). The overflow from Ford Dry Lake would be at about 152 m (500 ft); that level would encompass the entire Palen-Ford system.

Palen Lake is situated in a drainage basin of some 3500 km^2 (1350 mi^2) and the Ford Lake basin is about 5500 km^2 (2100 mi^2), exclusive of Palen Lake. Therefore, utilizing the same techniques as for the Bristol-Cadiz-Danby system, Palen Lake would exist as a marshy lake (2.5 m) when rainfall was more than 1.3 times the current average. Thus, when Bristol, Cadiz and Danby Lakes were moist mud flats or full and fluctuating lakes, Palen Lake was an active marsh overflowing into Ford Lake. Ford and Cadiz Lakes responded similarly to the climatic regime.

SECTION III

RESEARCH - ARCHAEOLOGY

By John Cook, Dennis Gallegos and Cliff Gates

3.1 OBJECTIVES AND ASSUMPTIONS

3.1.1 Objectives

In 1973 Margaret Weide was contracted by the BLM to develop a methodology for the inventory of the California Desert (Weide 1973). This methodology, although modified by the Bureau of Land Management's Desert Planning Staff, is still the groundwork for the BLM Cultural Resources Inventory of the California Desert. The objectives and assumptions within this methodology initiated by Weide are as follows:

Objectives

1) The discovery, recognition or elaboration of patterns of past human use and occupation of the study area;

2) The determination of the cultural resource potential of the study area;

3) The prediction of zones of greater or lesser activities by past human populations;

4) The identification and assessment of the environmental and/or cultural variables, or combination of variables that form the most accurate predictors of cultural resource sites;

5) The development of projections of expected density, distribution, dispersion and diversity of cultural resources;

6) The discovery of the range of cultural resource variability within the study area;

7) The provision of an objective means of assessing the existing cultural resource inventory;

8) The development of a systematic basis for making planning decisions concerning cultural resources.

3.1.2 Assumptions

- Extraction of economic resources was a significant determinant of the land use patterns practiced by the aboriginal inhabitants of the California Desert. Location of archaeological sites, therefore, will have a regular relation to the distribution of economic resources used by the past inhabitants.

- While we do not know these past economic systems in detail, or how the distribution of economic resources has changed through time, we may expect that they are closely related to current plant zones, physiography and hydrology.

- That relations between these variables and archaeological locales are of sufficient strength that predictions of site densities and locations can be generated for management purposes.

3.2 Sampling Design

In order to comply with the objectives and assumptions as outlined by Weide (1973) and the BLM requirements (see Appendix A), a three-phase sampling design was developed.

3.2.1 Phase 1

This phase was divided into three stages.

- Stage 1 was a nonarbitrarily stratified, systematic sampling design using geomorphology and vegetation as the stratifying variables. This sampling design was selected because it allows for: 1) an equal sample of each stratum within the sampling universe for comparative analysis of site type and density projections; 2) an estimation of the amount and kinds of cultural resource potential within the sampling stratum; 3) the dispersion of sample units throughout the sampling universe, rather than random sample clustering; 4) a more accurate predictor when compared to simple random sampling (Gleason 1920; Haig 1929; Hasel 1938; Westman 1971); and 5) a more efficient means of adjudging spatial distribution (Holmes 1967).

- Stage 2 increased the number of sample units within select Stage 1 strata. These additional units were selected within small strata which were previously sampled with only one or two sample units.

- Stage 3 involved the systematic sampling of six of the total 32 springs. This stage was sampled separately from Stages 1 and 2 because springs could not be given an areal limitation and would not fit easily into a geomorphically-based sampling scheme. Springs were sampled as points within cadastral grid limitations.

3.2.2 Phase 2

Phase 2 consisted of subregional block sampling. The sample universe was restratified into blocks which were then systematically sampled in order to examine and clarify apparent environment/site relationships noted in Stage 1. Subregional block sampling uses the concept that a sample from systematically selected blocks will reflect the larger homogenous sampling stratum. In this case, the subregional blocks were four miles wide beginning within each mountain and extended outward three miles. Blocks were approximately 20 sections in size and were sampled at the 2 percent level.

3.2.3 Phase 3

Phase 3 was a purposive (judgmental) field inventory of the dry lakes and dune systems supervised by Dr. Emma Lou Davis. These environmentally complex areas could not be understood through the 0.05 percent level of systematic sampling performed and a nonrandom approach was used in conjunction with Phase 1 inventory (see Section 4).

3.3 PHASE 1 SAMPLING STRATEGY

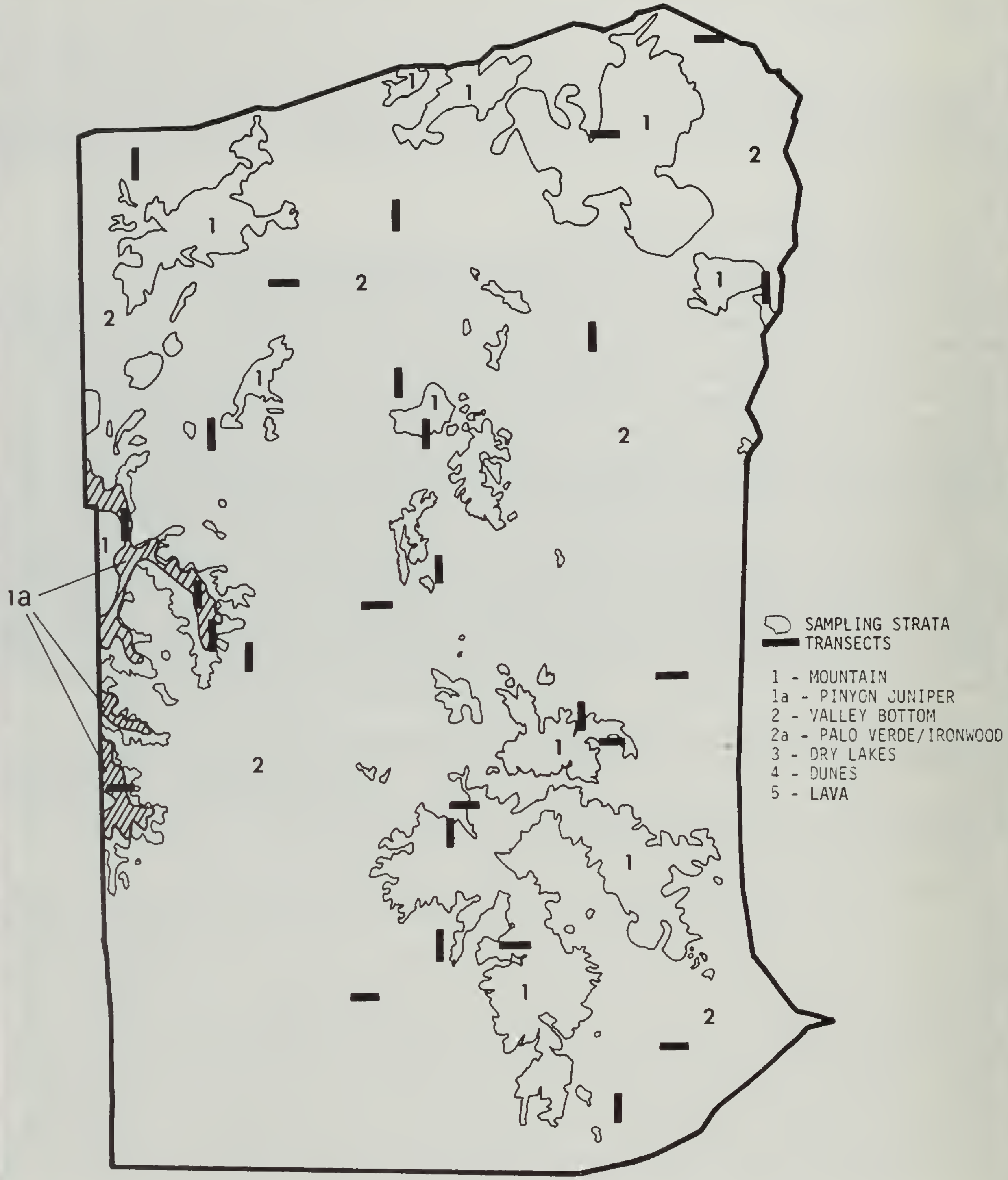
Sampling, dependent on environmental variables, generally assumes that vegetation, water resources and geomorphology have remained unchanged. This assumption holds true for late prehistoric and historic periods and then diffuses as earlier time periods are considered. For example, springs have been known to go dry or suddenly appear after an earthquake, and vegetation patterns have changed greatly within the last 100,000 years, probably with many wet and dry cycles (see Section 2.5 for Late Pleistocene discussion and Figures 2-6 and 2-7). Because of the diffusion and the lack of reliable vegetation data for the study area, the Phase 1 sampling universe (Turtle Mountains, Bristol/Cadiz and Palen planning units) was stratified primarily by geomorphology and secondarily by vegetation. Springs were sampled separately.

The five geomorphological strata are the topographically distinct Mountains/Hills (M), Valley Bottom (VB), Dry Lakes (DL), Dunes (D), and Amboy Lava Area (L). The two vegetation strata are Pinyon/Juniper (PJ) from the Mountain/Hill stratum and Palo Verde/Ironwood/Smoke Tree (PI) from the Valley Bottom stratum. The Mountain/Hill stratum was delineated by Brenner's (1978) "Tentative Landform Classification," and a 30 percent slope criteria, measurable on USGS quadrangles.

Lava, Dunes, and Dry Lakes strata were delineated as shown on USGS 15 minute topographic maps. Valley Bottom stratum is defined as non-Mountain/Hill, Lava, Sand Dune or Dry Lake strata. Vegetation strata for Pinyon/Juniper and Palo Verde/Ironwood/Smoke Tree were obtained from the USDA Forest Service's 1978 landsat vegetation study entitled "CALVEG" (see Figures 3-1a, 3-1b, and 3-1c).

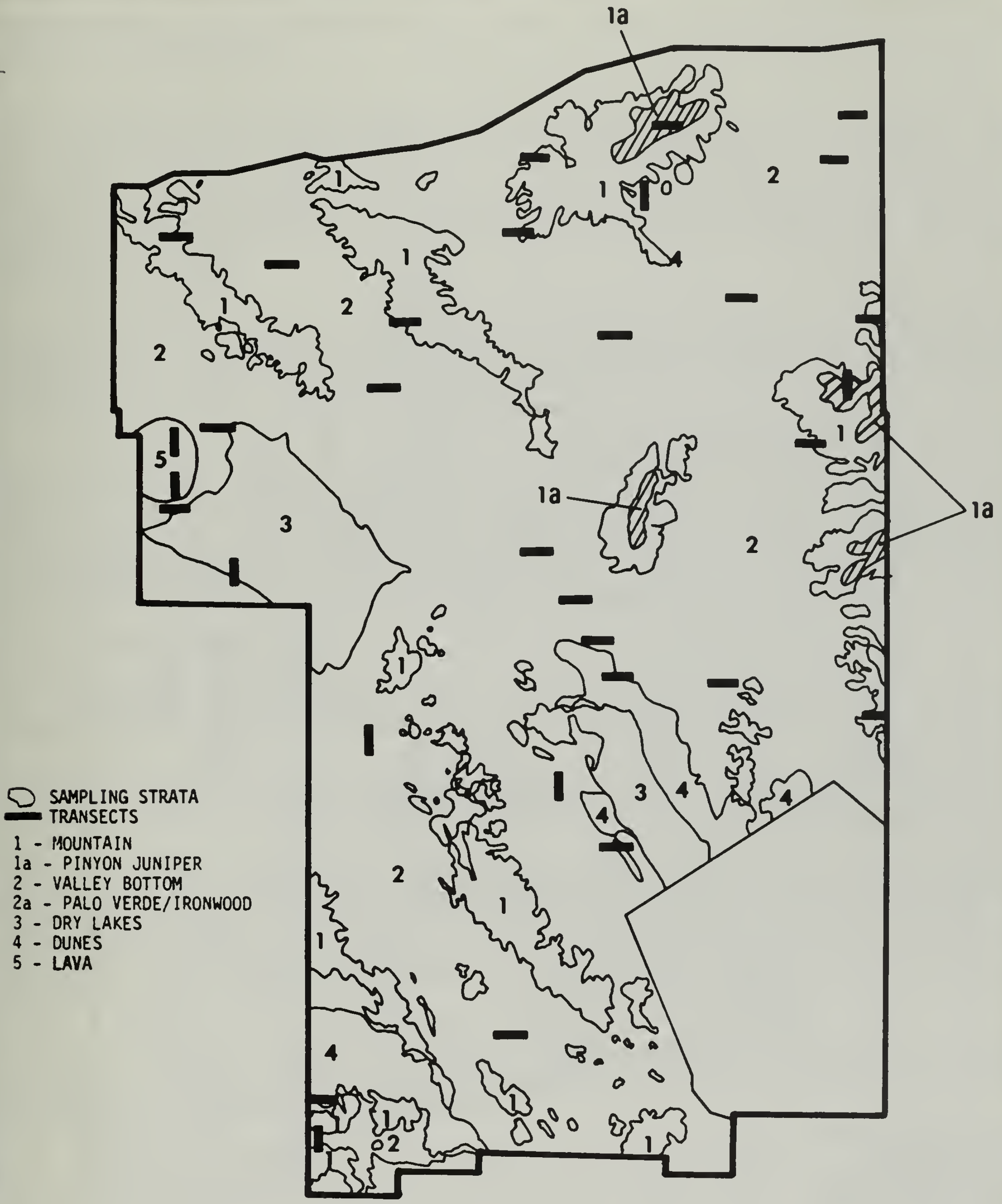
The geomorphological strata were then divided by square mile (cadastral grid) and a 51 percent rule was applied. For example, a section with 51 percent Valley Bottom and 49 percent Mountain/Hill would be placed in the Valley Bottom stratum. The sections were then totaled and 0.025 of the total area to be sampled was determined within each stratum. The geomorphological stratum were then subdivided into vegetation strata and a 0.025 sample allocation was selected from these strata. For all strata, the first section was randomly selected and then an interval was used to ensure dispersed sampling coverage of each stratum. After the section was selected, one of 16 possible north/south and east/west (1/8 mile x 1 mile) transect orientations was randomly selected. A total of 78 transects was selected in Stage 1 (see Table 3-1). These transects provided a 0.24 percent coverage and comprised approximately 50 percent of the total sample units available for the study.

Additional transects were selected for the Lava, Pinyon/Juniper and Dry Lake strata. These additional Stage 2 transects were selected within the Stage 1 sampling matrix and also utilized interval spacing. One additional sample unit from the Lava



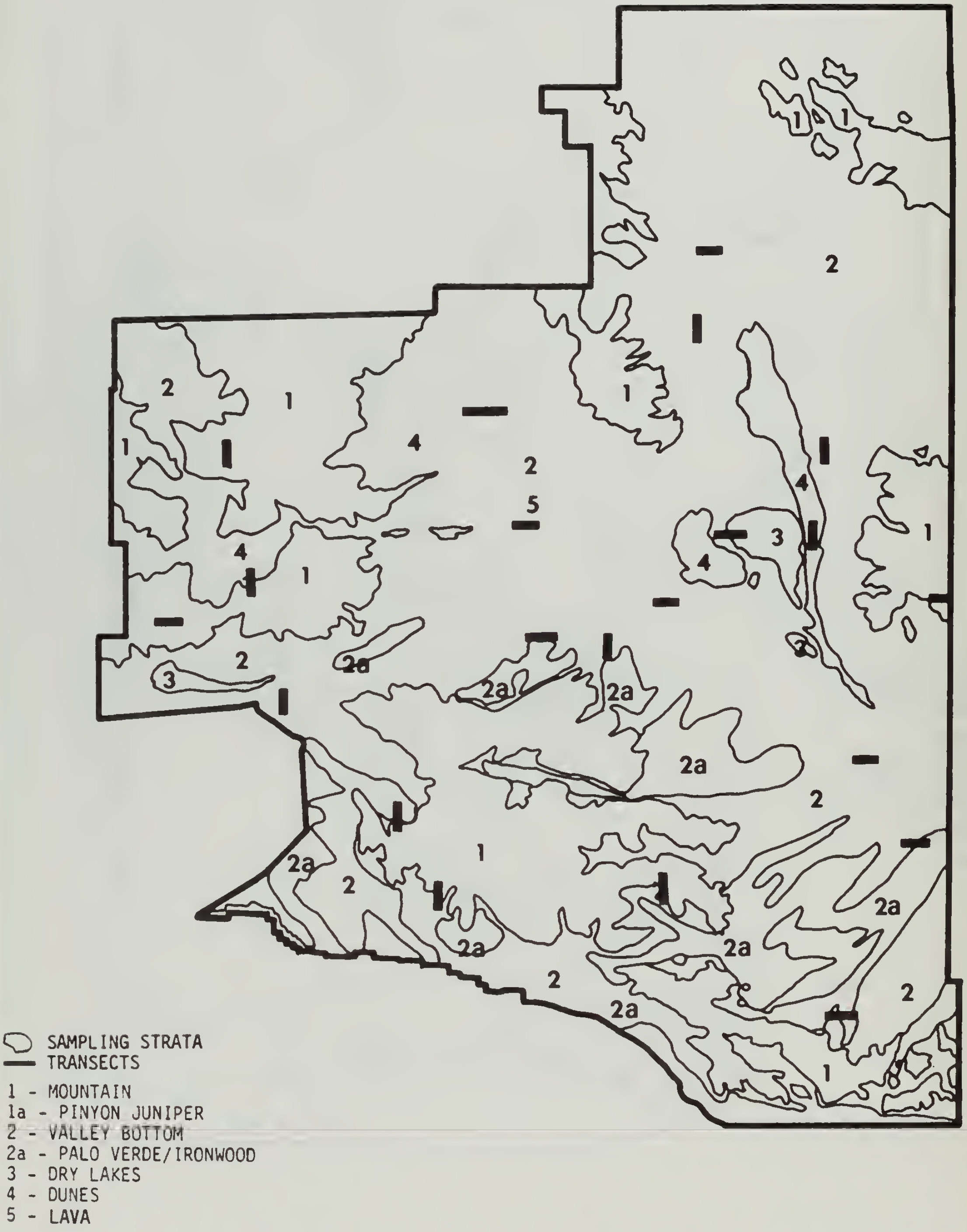
Turtle Mountain Planning Unit Stage 1 and 2 sampling strata and transect locations

FIGURE 3-1a



Bristol/Cadiz Planning Unit Stage 1 and 2
sampling strata and transect locations

FIGURE 3-1 b



Palen Planning Unit Stage 1 and 2 sampling strata and transect locations

FIGURE 3-1c

stratum, five from the Pinyon/Juniper and one from the Dry Lake stratum were selected (see Table 3-1).

Certain sample units were selected in advance of Stage 1 results because it was felt that these strata needed more sample units than were allocated in Stage 1. The Lava and the Pinyon/Juniper strata were sampled near the 1.75 level. Originally, the Dry Lakes were to be sampled at the two percent level within Phase 1. This was changed since it was felt that due to the complexity and the low level of sample inventory this effort could be applied better to the Phase 3 purposive Dry Lake inventory.

The inventory of springs is identified as Stage 3. Springs are points from which activity radiates and no limitation of sampling area could be ascertained; it was thought inappropriate to figure percent of coverage sampled. Thus, spring inventory was not included within Stage 1 or 2 sampling stages.

Thirty-two springs were located on USGS topographical maps. Sections with springs were numbered, and six sections were randomly selected (see Figure 2-1). The first selection was selected at random, the remaining five spring sections were selected using an interval from the first selection to provide sample spacing throughout the study area. One of two possible transect orientations (north/south or east/west) within each selected section was randomly selected for each spring.

3.4 Field Methods

The field inventory followed BLM specifications contained in Contract #YA-512-CT8-163 which are summarized below:

1. The transects were located by vehicle odometer, bench marks, topographic map study, Brunton sightings, and pacing.

2. Sample transects were walked in four evenly spaced sweeps, when possible (see Appendix A, Attachment 2). If the mountain terrain was steep, but had accessible mountain ridges, then the mountain ridges were walked. If the mountain transect was not accessible for reasons of personal safety, then these transects were scanned by helicopter. Two-people crews, making a sweep up and a sweep back, were primarily used.

3. A transect record was kept; on it were registered transect location, crew, date, area covered, vegetation, fauna, geology/geomorphology, hydrology and sites recorded (see Appendix A, Attachment 5).

4. All archaeological and historical sites were recorded on BLM site survey forms (see Appendix A, Attachments 3 and 4). These records included site type, features, artifacts, depth of midden, cultural affiliation/historical themes and environmental setting.

5. All sites and transects were recorded on USGS 15 minute topographic maps.

Table 3-1

PHASE 1, STAGE 1 and PHASE 2 STRATA COVERAGE

% of Area	Strata	Total Area in sq. mi.	Phase 1, Stage 1 Transects	Phase 2 Transects	% of Coverage Phase 1, Stage 1	% of Coverage Phase 1, Stage 1 & Phase 2
19.9	Mountain/Hill	796.	16		0.25	0.25
71.2	Valley Bottom	2850.	54		0.24	0.24
2.5	Dry Lakes	100.	2	1	0.25	0.375
2.3	Dunes	90.	2		0.28	0.28
0.4	Lava	16.	1	1	0.78	1.56
1.0	Pinyon/Juniper	40.	1	5	0.31	1.87
2.7	Palo Verde/Ironwood	108.	2		0.23	0.23
100.0		4000.0	78	7	0.244	0.27

6. Two 35mm color slides from the center of each transect, in opposing directions, were taken, in addition to select site photographs.

7. Drawings and photographs were made of select artifacts and features. If these data were not sufficient for field analysis, then the artifact was collected. One piece of each pottery type was collected for typing and distribution analysis.

3.4.1 Personnel

The following persons contributed to the successful completion of the many contract-required field tasks: Dr. Emma Lou Davis; Richard Carrico; Dennis Gallegos; John Cook; Dr. Paul Ezell; Jay Thesken; Sandy Day; Susan Carrico; Frank Norris; Lesley Eckhardt; Gary Lowe; William Eckhardt; Tracy Selvadurai; Suzie Arter; Mark Roeder; and Cliff Taylor. BLM Desert Planning Staff archaeologists Eric Ritter, Richard Brook and Suzanne Crowley were also active contributors.

3.4.2 Dates of Fieldwork

Approximately 245 field-person days were expended during the months of July, August, September and October of 1978.

3.4.3 Crew Qualifications

The qualifications of all personnel were carefully screened; individual resumes and previous work experience were examined and evaluated.

Each surveyor received a project packet which included: project goals; area geology and vegetation information; a summary of previous work in the area; instructions for filling out all forms; a slide presentation of artifacts, sites, and actual artifacts from the area (courtesy of the San Diego Museum of Man); and emergency information recommendations. Each crew member also received information listing locations and phone numbers of the nearest medical facility, the Sheriff's office, gas stations, and motels.

The majority of the survey work was completed by six surveyors. New crew members were paired with one of the six main surveyors. A constant rotation of crew members was in effect to allow a constant exchange of information, to provide escape from a rigorous routine, and to ensure an equalizing effect on the amount and kind of data acquired.

3.4.4 Transect Coverage

A total of 168 transects was inventoried by the WESTEC Services team; 142 of the 145 randomly selected transects were walked. Three Pinyon/Juniper transects (PJ-17, 19, and 20) were not walked because of extremely steep mountain slopes, and the lack of a safe helicopter landing area. These three transects were visually inspected by helicopter. It was assumed that the area did not contain sites if it could not be walked safely and if no potential site areas were seen from the helicopter. No additional transects were selected to replace these Pinyon/Juniper areas. In the case of steep mountain areas that could be walked by limited approach (ridges), the ridges were surveyed intensively and interval spacing was not maintained. Of the remaining 23 judgementally selected transects, a combination of walking and riding in a three wheeled dune vehicle (ATC) was used.

3.4.5 Field Problems and Site Identification Restrictions

One hundred percent site identification cannot be guaranteed because of situations unique to the study areas. Accurate inventory and assessment were limited for the following reasons:

1) Intensity of Inventory: The surveyors were evenly spaced approximately 50 meters apart. This distance potentially allowed small sites (i.e. flake scatters or isolates) to be missed.

2) Type of Terrain: Mountainous or rugged terrain was difficult to access, sometimes dangerous to crew members and created poor visibility. Dune areas also created accessibility problems; dry lakes, when wet, produced quagmires.

3) Nature of Environment: Numerous natural conditions can mask sites either temporarily or permanently. A dune system, where sites appear and disappear depending on wind and water, is an example of a temporary mask. Alluvial activity can permanently mask or destroy sites. In the case of areas such as Valley Bottoms, constantly advancing alluvium may have buried and/or dispersed sites. In the case of dispersion, numerous sites are created from an original single site. For example, water activity may spread a pottery locus across an Alluvial Fan/Valley Bottom area to make 10 archaeological sites (isolated potsherds); another possibility is that 9 of the 10 sites were buried, leaving only one potsherd on the surface.

Water action, erosion and deposition are the greatest natural threats to cultural resource sites. Vulnerable sites located at mouths of canyons, near intermittent streams, at the bases of mountains and near dry lakes can be washed away or covered by torrential flash floods. Flash floods are not a regular occurrence, but they can produce a tremendous volume of water within a short time period without prior warning.

4) Recordation of Sites: An archaeological locale or occurrence was recorded as a separate, distinct manifestation (site) if it was located 50 meters or more away from the last site. This BLM site-definition rule was difficult to follow in the case of No. 3 above (nature of environment), particularly when the site was located in a lithic resource area.

Lithic resource areas can be quite extensive and very similar in nature, ranging from intensive flaking stations to isolated flakes. The site area may be located in a natural source area for stone tools and the activity may have involved simply rock knocking to test the type of material. Any and all of these testing areas qualify as archaeological sites; they represent a consistent activity over an area. The area may be as large as three miles by two miles in size; in this case, recordation of every single site can be an exhaustive task.

5) Ground Cover: The desert provides excellent visibility of archaeological sites; but an isolated artifact or a small site can be hidden by vegetation and/or landform in certain cases.

6) Actual vs. Mapping: The actual location of the transect and the site may differ in the area walked and the area mapped. The study area was quite large; the roads and landmarks were few. The margin for error increased in hilly areas where ridges were similar and in valley bottom areas where the nearest landmark was 15 miles away, necessitating three miles of pacing on a compass directional.

7) Time Constraints: Time was a limiting factor in the case of sample units located where a helicopter was the only feasible method of transportation. To efficiently use survey crews and helicopters, movement of survey teams had to be kept to a schedule.

In certain areas, a survey was halted in the evening due to inadequate light, and resumed the following day.

8) Date of Survey: The survey was conducted during the months of July, August, September and October. This time of year presents the worst possible survey conditions with temperatures exceeding 120 degrees.

Crews started the day very early (4:30 a.m.) and worked in morning light and afternoon glare. Beginning work at 4:30 a.m., coupled with the extreme temperatures, caused the crew members to tire and may have affected their survey performance.

Four crew members developed heat prostration and/or related symptoms. Vehicle problems related to the extreme heat included radiator, air conditioning (necessary for medical aid), water hose, and citizen band radio failures.

9) Survey of Springs: Springs are points from which activity radiates, depending on geomorphological limitations. For instance, if the spring is on level terrain then the site may be dispersed around the spring; whereas, a spring located in a narrow canyon with few level areas above the flash floodline will produce sites primarily on these flat areas or linearly within the steep canyon. BLM specifications required transects to be within a cadastral grid; therefore steep mountain slopes may have been sampled; but the site near the spring was not recorded in the sampling of springs (Stage 3) because the site was not in the transect.

10) Dry Lake/Dune Inventory: In retrospect field tactics could have been improved. Stage 1 and 2 sampling strategy proved to be too general and over-simplified for the complex dry lake and dune systems. Instead of sampling the area as a single strata entitled "Dry Lake" a more appropriate term would have been "Catchment Basin" and in turn sub-stratified as

a) Water Input

b) New dunes, stabilized dunes, fossil dunes

c) Shores

d) Playa

The potentials and problems inherent in each lake-valley could have been better anticipated by laying out Quadrangle sheets eight at a time accompanied by a Geologic Map, splicing the Quadrangle sheets together and marking in color code such major variables as mountain volumes; every drainage; high lake stands; contemporary lake shores. These would point to areas with high archaeological probability as well as high-risk localities such as quicksands and sand dunes. These procedures of marking the maps for high visibility must be tried in order to appreciate the dramatic display - particularly of the direction and amount of drainage (indicators of available water). The procedure shows at once why the east end of Dale Lake is archaeologically sterile while Pinto Basin (just over the ridge) is archaeologically rich. Angle of mountain structures; slope angle and basin contours directed local rainfall away from Dale Valley and into Pinto Basin where shallow water could be impounded and marshes could form. The bold color-coded maps demonstrate what nature is doing in the huge, desert landscapes. (Archaeologists working in the California Desert Conservation Area are looking at a land mass roughly the size of Massachusetts, Connecticut and New York states combined.) Color-coded over-drawings bring the natural activities to life, so that each mountain perimeter and its catchment basin can be appraised as a dynamic whole.

The field problems of driving in deep, dry sand and in utilizing advice of local informants, encountered in the first field session were solved in the second field session by renting a Honda ATC (all terrain cycle), a slow-moving vehicle with phenomenal performance both in dunes and on sheet-sand, undermined by rodent burrows, and by finding employees of Hill Brothers, Lee Chemical and Delta Salt Mining companies who were able to give advice about access trails to the lakes.

3.5 Phase 1 Analysis

The primary objective of Phase 1 analysis was the examination of acquired data and the evaluation of the efficacy of the sampling design. Stages 1, 2 and 3 data analysis presented in this section is restricted to a descriptive summary and preliminary analysis of selected, pertinent variables (see Appendices H, I). Given the limited sample size at this juncture, many inferences and generalizations cannot be made with reasonable confidence. A more detailed analysis of Stages 1, 2 and 3 data in conjunction with Phase 2 data is presented in a later section of the text.

Stage 1 inventory produced 27 archaeological sites. The majority of these sites were lithic scatters (51 percent) and isolates (18.5 percent)(see Table 3-2). These sites are located in the Mountain/Hill, Valley Bottom and Lava Strata (see Table 3-3).

Stage 2 inventory produced two lithic sites within the Lava Stratum and no sites within the Pinyon/Juniper or Dry Lakes Strata.

Stage 3 spring inventory produced 12 sites from a total of 6 transects. These sites ranged from habitation to lithic, pottery and trail sites.

Table 3-2

SAMPLE STAGE BY SITE TYPE

*	Stage 1	Stage 2	Stage 3
1			1 (8)
2	2 (7)		2 (17)
3	1 (4)		
4			
5	14 (51)	1 (50)	4 (33)
6			
7	1 (4)		2 (17)
8			
9			
10			
11			
12	1 (4)		
13			
14	1 (4)		2 (17)
15			
16	5 (19)	1 (50)	1 (8)
17			
18			
19	2 (7)		
TOTAL	27 (100)	2 (100)	12 (100)

( ) = percent

*

1 = Village
2 = Temporary Camp
3 = Shelter/Cave
4 = Milling Station
5 = Lithic Scatter
6 = Quarry Site
7 = Pottery Locus
8 = Cemetery
9 = Cremation Locus

10 = Intaglio
11 = Rock Alignment
12 = Petroglyph
13 = Pictograph
14 = Trail
15 = Roasting Pit
16 = Isolated Find
17 = Cairn
18 = Historic
19 = Cleared Circle or Rock Ring

Table 3-3

STRATA TRANSECTS AND SITES

Stage 1 Strata	# of Transects		Transects W/ Sites		# of Sites per Transect						# of Sites	
					0	1	2	3	4	Over 4		
1. Mountain/ Hill	16	17	5	5	11	3	2	0	0	0	7	7
2. Pinyon/ Juniper	1		0		12	0	0	0	0	0	0	
3. Valley/ Bottom	54	56	10	10	44	6	2	1	0	1	18	18
4. Palo Verde/ Ironwood	2		0		2	0	0	0	0	0	0	
5. Dry Lakes	2		0		2	0	0	0	0	0	0	
6. Dunes	2		0		2	0	0	0	0	0	0	
7. Lava	1		1		0	0	1	0	0	0	2	
	(78)		(16)		(62)	(9)	(5)	(1)		(1)	(27)	
Stage 2												
1. Pinyon/ Juniper	5		0		5	0	0	0	0	0	0	
2. Dry Lakes	1		0		1	0	0	0	0	0	0	
3. Lava	1		1		0	0	1	0	0	0	2	
	(7)		(1)		(6)		(1)				(2)	
Stage 3												
1. Springs	6		4		2	2	1	0	0	1	12	
Stages 1, 2 and 3 TOTAL:	91		21		70	11	7	1	0	2	41	

Stratification of the sample universe was based on water resources, geomorphology and vegetation, each possessing minimally two states or variates. These are summarized below:

Water Resources

H_1 - Spring

H_2 - Other

Geomorphology

G_1 - Valley Bottom

G_2 - Mountain/Hill

G_3 - Dry Lake (Playa)

G_4 - Sand Dune

G_5 - Lava

Vegetation

V_1 - Pinyon/Juniper

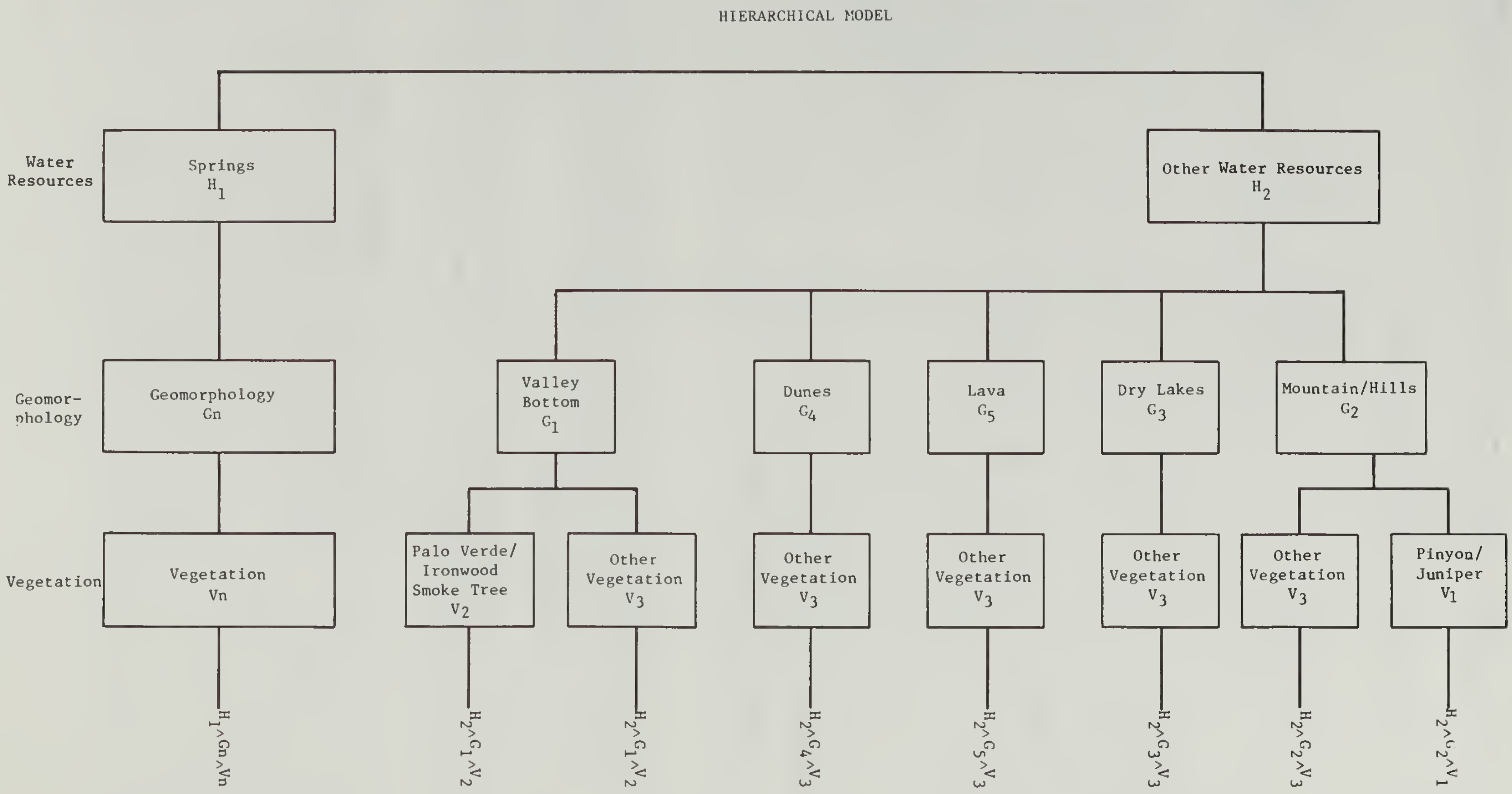
V_2 - Palo Verde/Ironwood/Smoke Tree

V_3 - Other

Each stratum is defined as a multivariate set, comprised of one attribute from each of the variables. For all practical purposes, stratification is a classificatory device in which environmental variability is presumed relevant and sensitive to variance in the phenomena investigated (i.e. archaeological sites).

As can be seen, the various strata summarized in Figure 3-2 (hierarchical model) are abbreviated forms of more complex relationships (e.g. other Water Resources, Dry Lakes - Other Vegetation is denoted as $H_2G_3V_3$).

Hierarchical relationships can be introduced into the classificatory scheme given that water resources, geomorphology and vegetation were discrete sampling sets or subsets. The purposeful introduction of hierarchical structuring upon classifications is especially useful because variability can then be examined at a number of different levels both horizontally and vertically. Table 3-4 shows the success ratio by hierarchical structuring. Ratio 1 is the number of transects with one or more prehistoric sites divided by the total number of transects (see Table 3-4). Ratio 2 is the total number of sites divided by the total number of transects. Note, however, that the ratios should be considered only relative indicators since none of the strata subsamples may be used to ascertain population parameters at the 0.10 confidence level.



Hierarchical Model

FIGURE 3-2

Table 3-4

SUCCESS RATIOS BY HIERARCHICAL STRUCTURING

	Ratio 1	Ratio 2
Overall	0.22	0.34
Water Resources		
H_1 - Springs	0.67	2.00
H_2 - Other	0.21	0.33
" * Geomorphology		
G_1 - Valley Bottom	0.18	0.30
" * Vegetation		
V_2 - Palo Verde	0.00	0.00
V_3 - Other	0.19	0.31
G_2 - Mountain/Hill	0.29	0.41
" * Vegetation		
V_1 - Pinyon/Juniper	0.00	0.00
V_3 - Other	0.31	0.44
G_3 - Dry Lakes	0.00	0.00
G_4 - Dunes	0.00	0.00
G_5 - Lava	1.00	2.00

---

* = and

Ratio 1 is the number of transects with one or more prehistoric sites divided by the total number of transects.

Ratio 2 is the total number of sites divided by the total number of transects.

Examination of this table identifies several readily apparent distinctions. The relative magnitude of difference between the ratios for water resources strongly indicates the influence permanent water sources exert on site location and, more basically, simple presence/absence of sites, i.e., H_1 vs H_2. The observed differential is in accordance with the idiographic and theoretic expectations; therefore, it is not unwarranted to accept the validity of the observed differences.

Equally apparent are the distinctions between "Lava" and the remaining geomorphological types, and between the differentiated Pinyon/Juniper and Palo Verde, and undifferentiated "Other Vegetation" categories. In the first case; observed differences are in agreement with hypothetical expectations, though magnitude of this distinction was not anticipated. The results in the second case seem to be an anomaly, for both Pinyon/Juniper and Palo Verde/Ironwood/Smoke Tree are hypothetically of high resource value (see Section 2.3 - Vegetation) and consequently were expected to have had greater site densities than the undifferentiated "Other" category.

Before proceeding with the analysis, it is imperative to further qualify some of the interpretations made with respect to sample confidence in Stage 1. First, even though no attempt is made to statistically infer population parameters from the limited sample, it is necessary to gauge the overall reliability. When analyzing the various success ratios at the strata or subsample level, reliability is considerably lessened. This is particularly true as the sample population or potential units of observation become smaller (e.g. strata having small areas such as Pinyon/Juniper, Lava, etc.). In recognition of this problem, but not in resolution, additional transects were expended in the Dry Lake, Lava and Pinyon/Juniper strata. Dry Lake, Lava and Pinyon/Juniper strata are each treated in more detail later in this section.

The remaining strata (Mountain/Hills and Valley Bottom) combined constitute the vast majority, some 91.9 percent in area, of the study universe (see Table 3-1). In addition, of all the stratum subsamples considered, these are probably the most reliable. Inspection of Table 3-4 shows the Mountain/Hill stratum consistently higher for both ratios than the Valley Bottom stratum; a proposition which runs somewhat counter to intuition. Given relative confidence in the samples, the two alternative interpretations of this inversion are: 1) the data, in fact, reflect reality and there actually are more mountain than valley bottom sites; or conversely, 2) such is not the case, and the data are inaccurate because of vagaries in measurement (often the result of difficulties experienced in operationalization). Visual analysis of Stage 1 results, strongly indicates the latter interpretation.

The source of this problem is the "51 percent" rule, necessitated by use of the cadastral grid system, applied during stratification. As previously discussed, sections containing two or more strata were designated and incorporated into the strata which represented over 51 percent of the section. Although practical, a loss of precision resulted from these ambiguous designations. The problem is further compounded as the individual stratum delineated becomes increasingly smaller in area, for as this happens, a proportionally larger percentage of the total stratum's area becomes incorporated into the periphery, the relative amount or proportion being a function of the coarseness of the grid system superimposed. Therefore, as the strata become smaller, the probable spatial distribution of random transects within the strata become increasingly skewed toward those sections with cross-cutting or multiple stratum. Tables 3-5 and 3-6 illustrate this problem.

Both tables summarize a stratification-related variable in respect to the presence or absence of prehistoric sites. Table 3-5 is a contingency table denoting the relationship between sites and a variable, termed "CROSPURE," which designates whether the transect is entirely within any specified stratum or cross-cuts two or more stratum. Notice that nearly one-third of all transects cross-cut strata. (It is also interesting to note that a chi square test calculated for this table results in a 2.03 value. With one degree of freedom, the test for presence/absence of sites to crosscutting or pure transects is significant at the 0.15 level, somewhat larger than the arbitrary 0.10 level set throughout this analysis, but nevertheless suggesting weak association).

Seven "cross-cutting" or "pure" transect types considered relevant for analytical purposes were identified as stratype. Table 3-6 summarizes the distribution of the presence or absence of sites by these stratype transects. Of the seven Stage 1 strata, excluding springs, only four transects were "pure" (completely within stratum boundaries), whereas five cross-cutting strata types were a result of the 51 percent rule. The implications are applicable not only for the operationalization problem, but also for the original question regarding the observed differences in success ratios between mountain and valley bottom strata.

With the exception of Lava, all stratype classified transects remaining in Table 3-6 are comprised entirely or partially of either Mountain/Hill or Valley Bottom geomorphological units. Eliminating Dry Lakes, Dunes, Palo Verde and Pinyon/Juniper, only "pure" Mountain/Hill, "pure" Valley Bottom and Mountain/Valley Bottom stratypes remain. By this process, 67 of the 70 original transects classified as Mountain or Valley Bottom remain. The difference was subsumed under the other stratypes. Based on the stratype reclassification procedure, 8 of the original 16 mountain transects are in reality "pure" Mountain (MT) compared to 43 of 54 for "pure" Valley Bottom (VB). The proportionally higher loss for mountain transects is a function of smaller area (see earlier discussion) and the spatial distribution and dimensional characteristic of each of the individual mountain ranges. The reclassification results in a substantial number of MT/VB type units which normally would have been overlooked. This operational ambiguity is important because the potentially undifferentiated MT/VB unit has a considerably higher success ratio (Table 3-6). The ratio for presence/absence of sites to total transects is found to be 0.44 for the MT/VB stratype, compared to 0.00 and 0.16 for MT and VB, respectively, or viewed differently, 0.44 compared to 0.14 for cross-cutting as opposed to "pure" stratypes. Even without full confidence in the subsamples, the disparity cannot be negated.

To this point, only stratification or similarly related variables have been considered in analysis. While it may be significant that success ratios co-vary with strata, this is only an empirical generalization. In order to identify and isolate related, plausible explanations it is necessary to introduce nonstratification variables into the analysis. One such variable is the presence or absence of desert pavement within the transect. Table 3-7 is a contingency table showing the distribution of sites by presence/absence of desert pavement.

Table 3-5

CROSS-CUTTING OR PURE TRANSECTS BY PRESENCE/ABSENCE OF PREHISTORIC SITES

CROSPURE		NO. OF SITES ABSENT	NO. OF SITES PRESENT	ROW TOTAL
	Cross-Cutting	17 (68.0)	8 (32.0)	25 (32.1)
	Pure	45 (84.9)	8 (15.1)	53 (67.9)
COLUMN TOTAL		62 (79.5)	16 (20.5)	78 (100.0)

( ) = Percent

Corrected chi square = 2.031 with 1 degree of freedom.

Significance = .1541

Table 3-6

STRATYPE TO PRESENCE/ABSENCE OF PREHISTORIC SITES

STRATYPE		NO. OF SITES ABSENT	NO. OF SITES PRESENT	ROW TOTAL
MOUNTAIN	1.	8 (100.0)	0 (0)	8 (10.3)
VALLEY BOTTOM	2.	36 (83.7)	7 (16.3)	43 (55.1)
LAVA	5.	0 (0)	1 (100.0)	1 (1.3)
PINYON/JUNIPER	6.	1 (100.0)	0 (0)	1 (1.3)
MTN AND VB	9.	9 (56.3)	7 (43.8)	16 (20.5)
VB - DRY LAKE	13.	2 (100.0)	0 (0)	2 (2.6)
VB - DUNE	14.	3 (100.0)	0 (0)	3 (3.8)
VB - PALO VERDE	21.	3 (100.0)	0 (0)	3 (3.8)
COLUMN TOTAL		62 (79.5)	16 (20.5)	78 (100.0)

( ) = Percent

Table 3-7

PRESENCE/ABSENCE OF PREHISTORIC SITES TO PRESENCE/ABSENCE OF DESERT PAVEMENT

		NO. OF SITES ABSENT	NO. OF SITES PRESENT	ROW TOTAL
DESERT PAVEMENT	ABSENT	44 (95.7)	2 (4.3)	46 (59.0)
DESERT PAVEMENT	PRESENT	18 (56.3)	14 (43.8)	32 (41.0)
COLUMN TOTAL		62 (79.5)	16 (20.5)	78 (100.0)

( ) = Percent

Corrected chi square = 15.63398 with 1 degree of freedom.

Significance = 0.0001

Testing for nonrandom association a *chi* square value (corrected for continuity with one degree of freedom) of 15.63 results in significance at the 0.0001 level. As a *chi* square value of 2.70 or greater is required to reject the null hypothesis at the 0.10 significance level, it may be concluded that a nonrandom association between sites and desert pavement exists. Though readily apparent, it is also possible to test for directionality, i.e. the alternative hypothesis poses either a negative or positive association, not merely the presence or absence. The level of significance is halved when directionality is proposed and the necessary *chi* square value then becomes 3.84. The null hypothesis is again rejected and a positive, nonrandom association between the presence of sites and the presence of desert pavement, and the absence of sites and the absence of desert pavement is assumed to exist (strength of association, measured by the *phi* statistic, is 0.48, denoting that a moderately strong relationship exists for this association).

Desert pavement is a formation that is the end result of the interaction of numerous natural agents occurring over several millenia. Many of the processes responsible for formation and preservation of these pavements also affect site deposition and, more importantly, insure site preservation. Although by no means the only mechanism for preservation, the strength of the association between prehistoric sites and desert pavement emphasizes the relevancy of "N-transforms" (Schiffer 1976). An embracive concept, N-transforms are statements which explicitly define the relationship between noncultural formation processes, such as water, wind, erosion, rodent activity, and the resultant post-depositional changes in the archaeological record. These natural processes significantly affect the probability of site degradation and destruction. Ultimately, the probability of locating an archaeological site within any given transect or strata is independent of its potential for cultural deposition. In desert environs, the importance of destructive or obfuscating N-transforms cannot be ignored; geographic change is constant and extensive. The unstabilized desert surface is particularly susceptible to radical modification because of the scarcity of vegetation and the potential for flash floods. Obviously, many other processes can affect N-transform probabilities and any attempt to assign exact probabilities are beyond the scope of this study.

Based on the foregoing statistical analysis, data strongly suggest that desert pavement is one such factor. The term "strongly suggest" is necessary; causality cannot be assumed, regardless of the fact that a moderately strong, positive, nonrandom association exists. Referring to the contingency table (Table 3-7), the presence of sites relatively assures that desert pavement will also be present; the presence of desert pavement does not assure the presence of sites.

Desert pavement is an important contribution to site preservation. This does not mean that desert pavement is an important factor in the determination of site location. Site location is the result of conscious and unconscious cultural behavior, and selection is independent of the eventual disposition of the material culture or artifacts. (In theory, certain limitations do exist especially for the more permanent, habitational sites, somewhat mitigating absolute independence.) The question becomes, "Why does there exist a differential distribution of sites on desert pavement?" First, it is necessary to determine the nature of differential site distribution. Table 3-9 combines the data from Tables 3-6 and 3-8; it relates the data by stratype to percent of transects with sites and to percent of transects with desert pavement. The table denotes the

Table 3-8

STRATYPE BY PRESENCE/ABSENCE OF DESERT PAVEMENT

		STRATYPE									
		MOUNTAIN	VALLEY BOTTOM	LAVA	PINYON JUNIPER	MTN AND VB	VB-DRY LAKE	VB-DUNE	VB-PALO-VERDE	MTN-VB PALO-VERDE	ROW TOTAL
DESERT PAVEMENT	ABSENCE	8	29	0	1	4	2	0	0	0	46
		(17.4)	(63.0)	(0.0)	(2.2)	(8.7)	(4.3)	(4.3)	(0.0)	(0.0)	(59.0)
	PRESENCE	0	14	1	0	12	0	1	3	1	32
		(0.0)	(43.8)	(3.1)	(0.0)	(37.5)	(0.0)	(3.1)	(9.4)	(3.1)	(41.0)
COLUMN TOTAL		8	43	1	1	16	2	3	3	1	78
		(10.3)	(55.1)	(1.3)	(1.3)	(20.5)	(2.6)	(3.8)	(3.8)	(1.3)	(100.0)

( ) = Percent

Raw chi square = 23.82046 with 8 degrees of freedom.

Significance = .0025

Table 3-9

SITES BY STRATUM TO DESERT PAVEMENT

Stratype	% of Transects With Sites	% of Transects With Desert Pavement
Pinyon/Juniper	0	0
Mountain/Hills	0	0
Mtn/Hills Valley Bottom	77	75
Mtn/Hills VB Palo Verde	100	100
VB Palo Verde	19	100
VB Dunes	0	33
VB Dry Lakes	0	0
Lava	100	100

total absence of desert pavement in Mountain/Hill, Pinyon/Juniper and Valley Bottom/ Dry Lake, and differences in the percentage of desert pavement. If these data were then ranked, Spearman's rule could be applied to test for correlation between sites and desert pavement by stratype; two problems negate the use of this statistic. Most importantly, sample confidence in the smaller stratypes is quite low, possibly resulting in spurious correlations; second, ranking necessary for use of Spearman's rule would result in too many ties, weakening the utility of the statistic. It is nevertheless possible to evaluate the distribution qualitatively.

Ordering the stratypes from Table 3-9, with the exception of Lava, an idealized geographic cross-section of an entire catchment basin is represented. The cross-section begins with the highest stratype, Pinyon/Juniper; through Mountain/Hill, Mountain/Valley and Valley Bottom until Dunes and Dry Lake stratypes are reached. Dunes and Dry Lake are the opposite extreme of the cross-section. As expected, both desert pavement and sites are absent from the Mountain/Hill - Pinyon/Juniper stratypes. The former absence probably results from highly-sloped terrain and the latter from possibly both natural and cultural factors. Dune and Playa, Valley Bottom geomorphic units also demonstrate lack of both sites and desert pavement. There appears to be an overall correlation between sites and desert pavement. A positive association of either the presence or absence of desert pavement and sites is apparent rather than a negative association (a combination of presence and absence of the two variables). The only exception to this interpretation is the Valley Bottom/Dunes stratype. Sample reliability is generally good for the larger stratypes (Mountain/Hill - Valley Bottom (M-VB) and "pure" Valley Bottom (VB), and the relationship between sites and desert pavement can be investigated in more detail. These stratypes represent the midsection of the cross-section and possess the greatest number of sites.

Statistical examination of the relationship between sites and desert pavement for MT/VB and VB stratypes results in a significant association for combined stratypes (Table 3-10). When these stratypes are analyzed separately, a significant relationship between sites and desert pavement exists only in the "pure" Valley Bottom. Due to the low number of observations, the Mountain/Hill - Valley Bottom stratype necessitated the use of Fisher's Exact Test, and was found not to have a significant correlation (Table 3-10). This suggests that site occurrence (the observed presence or absence) within the Mountain/Hill - Valley Bottom stratype is less dependent upon preservation factors (such as desert pavement) than the Valley Bottom stratype, which is comprised predominantly of alluvial fans. To simplify, the probability of finding sites and explaining their variability increases as one proceeds from valley center to mountain base. Greater numbers of sites exist at mountain base for reasons of cultural selection and differential site preservation.

3.5.1 Observed Results

Observations of site types in relation to distance from mountain base shows the overall average distance (excluding the Lava stratum) to be 2.1 km (1.32 mi). The range for all Stage 1 sites, in this relationship, is between 0.0 and 5.2 km (3.25 mi.) It also was determined that a mean of 0.48 km (0.3 mi) exists for habitation sites (including temporary camps, rock shelters and rock rings). The average distance was 2.44 km (1.5 mi) with a range of 0.0 to 5.2 km (3.25 mi) for lithic scatter sites and lithic isolates.

Table 3-10

PRESENCE (P)/ABSENCE (A) OF DESERT PAVEMENT TO PRESENCE/ABSENCE OF PREHISTORIC SITES FOR COMBINED MOUNTAIN/HILL - VALLEY BOTTOM AND VALLEY BOTTOM

		Sites		
		P	A	
Desert	P	13	13	26
Pavement	A	1	32	33
		14	45	59

$X_c^2 = 15.22$

Same as above for Mountain/Hill - Valley Bottom only

		Sites		
		P	A	
Desert	P	6	6	12
Pavement	A	1	3	4
		7	9	16

p = .323

Same as above for Valley Bottom only

		Site		
		P	A	
Desert	P	7	7	14
Pavement	A	0	29	29
		7	36	43

$X_c^2 = 12.8$

Stage 2 increased the Lava stratum area sample from 0.78 to 1.56 percent; both transects within the Lava stratum produced one lithic scatter and one lithic isolate site (see Table 3-2). A projection of these figures for the total Lava stratum suggests a potential of 16 sites per square mile (see discussion in 3.7.2).

A 2 percent inventory was achieved in the combined 1 and 2 stages for the Pinyon/Juniper stratum. This stratum was extremely mountainous, very difficult for access and survey coverage, and three of the six transects selected could not be walked. The three near-vertical transects were spot-checked when feasible and each was visually inspected by helicopter. The vegetation for this stratum varied from pinyon/juniper to juniper to creosote bush communities. The Calveg USFS study did not provide the necessary data to ensure a pinyon/juniper community for sampling.

Assuming a larger domain for the Pinyon/Juniper as suggested in Section 2.5 (see Figure 2-5), the sample is well within limits, but that was not the purpose of the delineation and sampling of the Pinyon/Juniper stratum. Pinyon/Juniper was thought to be a resource that would have attracted past peoples; so that the amount and type of use could be measured. Sampling revealed no archaeological sites in or near any of the six inventoried transects. The dearth of sites can be attributed to one or more of the following factors:

1. The Pinyon/Juniper in those particular areas was not an economic resource;
2. The rugged terrain obscured evidence of past use of this resource;
3. The sampled area was stratified incorrectly;
4. The area was not sampled at a high enough level to produce valid results.

In the Dry Lake Stage 2 inventory, 16 transects were proposed for a 2 percent survey, but only one of these transects was walked before this strategy was abandoned. Observations in Stage 1 showed the area delineated by USGS 15 minute maps to include alkali flats, salt mining areas, and dangerous quicksand areas lacking in archaeology. The initial Dry Lake effort was redirected to Phase 3 (Purposive Inventory) because it was impossible to adequately cover five complex lake shorelines and a multitude of dune systems by the limited number of transects available.

As previously noted, the spring inventory (Stage 3) was the most productive; four of the six transects walked contained sites. The 12 spring sites consisted of 25 percent habitation sites, 41 percent lithic sites and 34 percent trail and pottery locus sites. Table 3-11 shows the general location of the inventoried springs and the relationship of presence/absence of water to presence/absence of sites (also see Figure 2-1). Some of the observed springs appeared to be seasonal or cyclical, flowing only when the water table is very high, after a very wet season.

Table 3-11

SPRING/SITE TABLE

TRANSECT NUMBER	SPRING NAME OR LOCATION	WATER PRESENT	PRESENCE OF SITES
S-29	Unnamed/Old Woman Mtns.	Yes	Yes
S-30	Wilhelm/Old Woman Mtns.	No	No
S-34	Hayfield Summit Spring	No	No
S-35	Unnamed/Chuckwalla Mtns.	Yes	Yes
S-37	Piute Mtns. Spring	Yes	Yes
S-38	Old Woman Mtns. Spring	Yes	Yes

3.5.2 Stage 1 Site Distribution by Planning Unit

Table 3-12 shows planning unit coverage and return per planning unit per number of transects expended. Coverage of each planning unit generally is equal. Major differences are related to the productivity of planning units by transect and by number of sites. The Palen Planning Unit was the least productive; 3 of 25 transects produced 5 sites. Bristol/Cadiz Planning Unit produced the highest number of transects with sites. Turtle Mountain Planning Unit produced the highest number of archaeological sites.

3.6 Phase 2 Sampling Strategy

The Phase 2 inventory consisted of only one stage of sampling, constructed on the results of Phase 1 sampling. In summary, Phase 1 results show correlations of sites to springs, Lava stratum, desert pavement areas and the Mountain and Valley Bottom strata interface area. The Phase 1 results also show a lack of sites in stratype Pure Mountain with few sites extending over three miles from the mountain base towards the valley center.

The previous sample universe was stratified by Mountains, Valley Bottom, Lava, Dunes, and Dry Lakes with springs sampled separately. The Phase 1 springs and Lava strata were dropped from Phase 2 sampling as they were highly productive in sites. Pure Mountain stratype and Valley Bottom (over three miles from mountain base) were both generally unproductive and were for the most part dropped from further sampling; the dry lakes and dunes were purposively inventoried in Phase 3 and were not sampled further.

The remaining Mountain/Valley Bottom interface area, the most site productive area in Stage 1, was the focus of Phase 2 inventory. To delineate this new sample area,

Table 3-12

PLANNING UNIT COVERAGE AND RETURN

PLANNING UNIT	# OF TRANSECTS	# OF TRANSECTS WITH SITES	TRANSECTS WITH SITES TO TOTAL	# OF SITES	RETURN BY SITES TO TOTAL TRANSECTS
Bristol/ Cadiz	30 (38)	7 (47)	23%	11 (41)	37%
Turtle Mt.	23 (30)	5 (33)	20%	11 (41)	44%
Palen	25 (32)	3 (20)	13%	5 (18)	21%
TOTAL:	78 (100)	15 (100)	-	27 (100)	-

( ) = percent.

the previous sample universe was reorganized into subregions (strata). The total study area was delineated into subregions and only certain subregions were sampled. The subregions and areas sampled (see Figures 3-3a, b, c) are defined as follows:

- Subregion 1 - Valley Bottom Center. This area began three miles from the mountain base and continued to either the valley center or the Dune/Playa system (subregion 2).

- Subregion 2 - Dune/Playa System. This area included all of the playas and dunes as delineated on USGS maps plus some Valley Bottom sections surrounding the dunes and playas. Phase 3, purposive inventory (see Section 4), surveyed this area; therefore sample units were not expended in Subregion 2.

- Subregion 3 - Lava. Subregion 3 and Stage 1 Lava stratum are the same. The Lava was so productive in Stage 1 it was not sampled in Phase 2.

- Subregion 4 - Pure Mountain. This subregion was delineated to include only Mountain/Hill slopes of over 30 percent and generally does not include mountain base. This subregion was unproductive in Stage 1, and was therefore dropped from Phase 2 sampling.

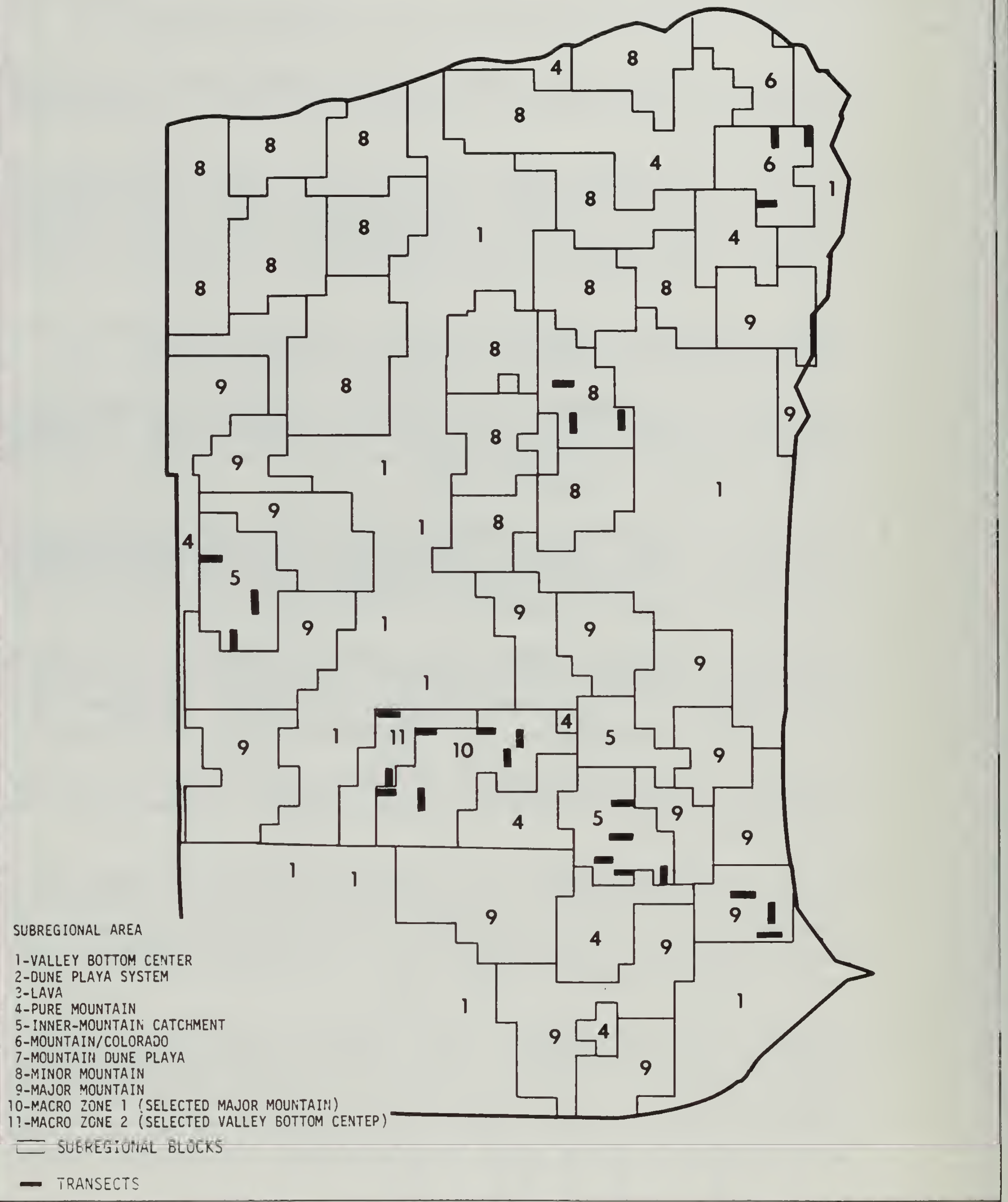
- Subregion 5 - Intermountain Catchment. These areas are defined as being over 15 square miles in size, delineated by mountain ridges, with restrictive basin mouths. Only the major mountain ranges (approximately 100 square miles or larger) contained intermountain catchments.

- Subregion 6 - Mountain/Colorado River. This area included the east side of the Sacramento Mountains, beginning inside the mountain base and extending three miles toward the Colorado River (valley center). Subregion 6 was detached and sampled separately due to its proximity to the Colorado River.

- Subregion 7 - Mountain/Dune/Playa. Mountains of any size which interfaced within three miles of mountain base with dune/playa (Subregion 2) were within this category.

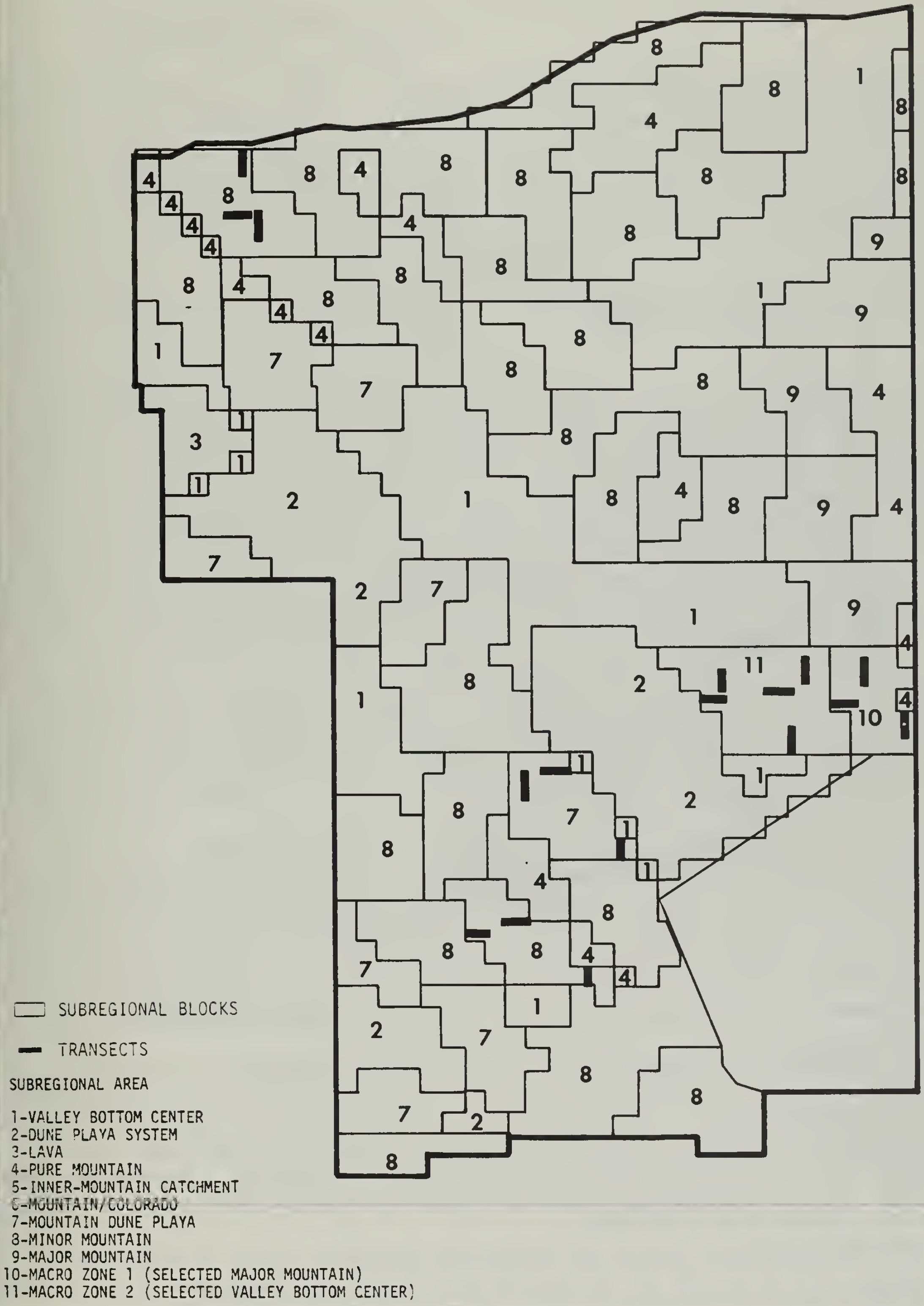
- Subregion 8 - Minor Mountain. This category was designed to include nearly all sections which contained mountain base and extended three miles from mountain base toward the valley center. Minor mountains are those ranges which are less than 50 square miles in size. This category included the west side of the Sacramento Mountains.

- Subregion 9 -Major Mountain. Major mountain included those mountain ranges approximately 100 square miles or larger. These ranges included the Turtle Mountains, the Old Woman Mountains, the Eagle Mountains, and the Chuckwalla Mountains. The reason for the major mountain and minor mountain distinction was that major mountains could hypothetically provide more resources (i.e. water, plants, lithic materials). The subregion includes



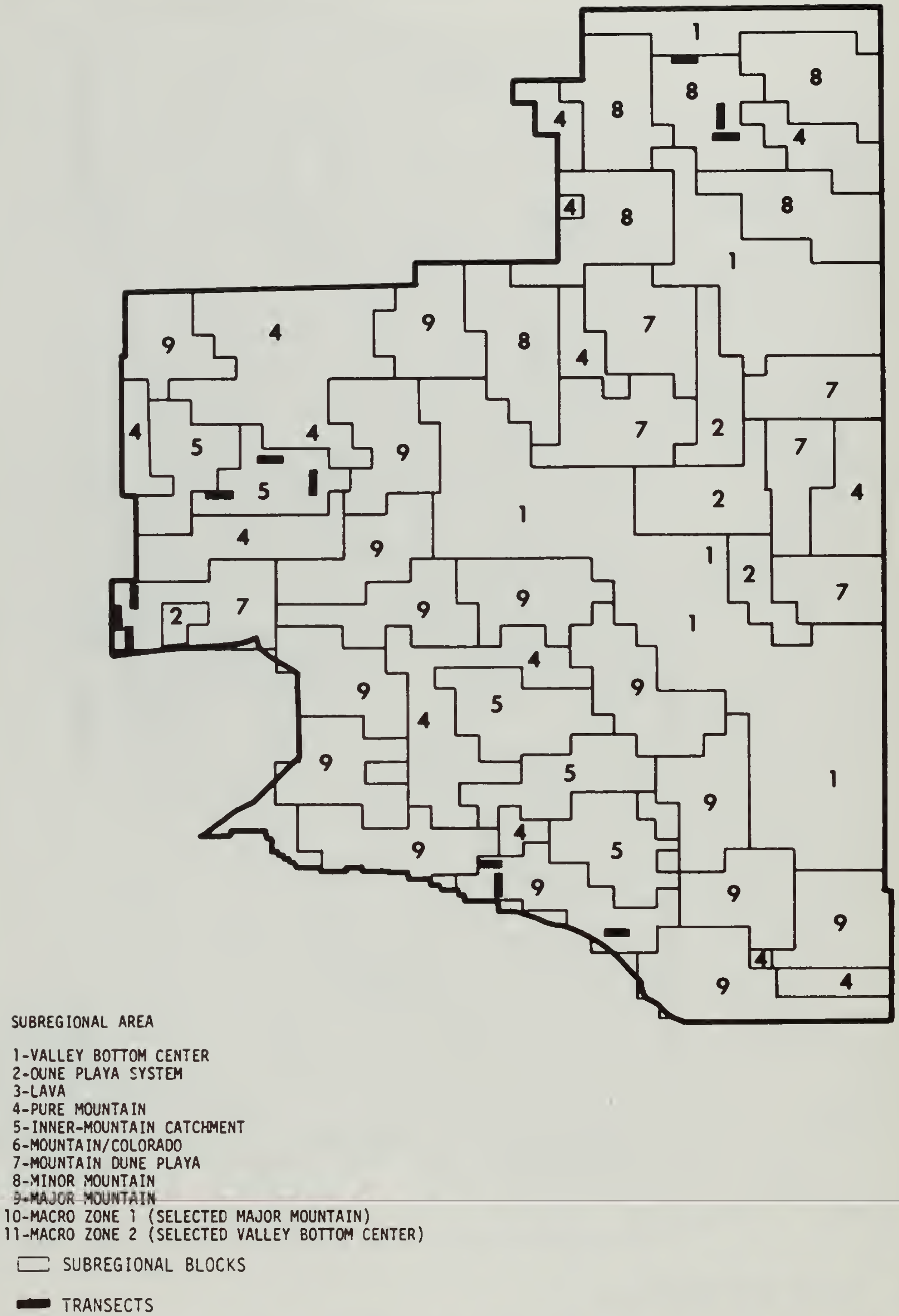
Turtle Mountain Planning Unit Phase 2, subregions, subregional blocks and transect locations

FIGURE 3-3a



Bristol/Cadiz Planning Unit, Phase 2, subregions, subregional blocks and transect locations

FIGURE 3-3b



Palen Planning Unit, Phase 2, subregions, subregional blocks and transect locations

FIGURE 3-3c

all sections which contain mountain base and extends three miles from mountain base to valley center.

- Subregion 10 - Macro Zone 1. Macro subregionals were delineated under the same principals as major mountain (Subregion 9). The distinction between subregions 9 and 10 were the size of blocks sampled and the association of Subregion 10 to Subregion 11. Subregions 10 and 11 were sampled together to form a macro subregional block. The sampling of both subregions 10 and 11 together was for the purpose of investigating site distribution from a major mountain range to the valley center.

- Subregion 11 - Macro Zone 2. This category included the area entitled Subregion 1 (valley center).

In Phase 2, only subregions 5, 6, 7, 8, 9, 10, and 11 were sampled. All of these subregions, except for 5, were blocked into either macro- or micro-subregionals and sampled at the two percent level. A macro-subregional block consists of only subregions 10 and 11 and was approximately 50 sections in size, divided into two zones. Zone 1 included the mountain base and extended out approximately three miles (depending on cadastral grid). Zone 2 began three miles from the mountain base and extended to the valley center. Only major mountains were sampled with macro-subregional blocks. A micro-subregional block was approximately 20 sections in size, included the base of a mountain, and extended three miles towards the valley center. Micro-subregional blocks were the most common units used in Phase 2 sampling.

Within each block the sections were numbered consecutively, the first section was randomly selected, the following sections were selected through the use of an interval to ensure spacing and movement of sample units from the base of the mountains towards the valley center. The section selected contained 16 possible 1/8 by 1 mile transect orientations; one of which was randomly selected for sampling.

Subregion 5, intermountain catchments, was blocked through both the use of natural ridges which created the catchments and the USGS cadastral grid. Eight catchments were delineated and using an interval three catchments were selected. Each catchment was sampled at the two percent level utilizing the 1/8 by 1 mile transect. The first catchment selected was on the east side of the Old Woman Mountains; the second was on the southeast portion of the Turtle Mountains (Vidal Valley); and the third was located in the southern portion of the Eagle Mountains.

Subregion 6, Mountain/Colorado River, was blocked into two micro-subregions for sampling, and a two percent inventory was completed of one.

The Mountain/Dune/Playa subregion was nearly equally blocked into 13 micro-subregional blocks. Two blocks were randomly selected, utilizing an interval to ensure spacing. A two percent sample (six transects) was then selected.

Subregion 8, minor mountain, comprises the largest subregion (1058 sq mi). A total of 54 micro-subregional blocks was delineated for this area; four of these blocks were selected. Twelve transects within these selected blocks were randomly chosen.

Subregion 9, major mountains, consists of 28 micro-subregional blocks, of which two were selected. A total of six transects was selected within these two blocks.

Two of a possible 11 macro-subregional blocks (Subregions 10 and 11) were selected. Sixteen transects were selected within the two zones of each macro-subregional block.

3.6.1 Phase 2 Sampling Results

A summary of subregional type, percent of sampling coverage, number of sites and site distribution is presented in Table 3-13. The Phase 2 sample universe was 2413 square miles of the original 4000 square miles for the total study area. Within this reduced sampling universe it should be noted that Mountain/Colorado River represents the smallest subregion, 1.6 percent of the Phase 2 sampling universe; Minor Mountain was the largest subregion at 43.9 percent. For these two subregions, respectively, the percent of sampling coverage ranges from 0.96 percent to 0.14 percent. Unlike Stage 1 where initially all strata were sampled at the 0.25 percent level; the range in percent coverage reflects the radically different approach and requirements of the Phase 2 sampling design. In order to ensure adequate coverage of the smaller subregional types, a seemingly disproportionately larger number of sample units was necessary. This, however, does not mean that larger subregional types were inadequately covered: the majority of Phase 1 transects were used within this Phase 2 universe and also the Phase 2 universe was 40 percent smaller than the Phase 1 sample universe.

It should be noted that the figures in Table 3-13 for macro-subregional zones 1 and 2 are somewhat misleading since these subregions represent special instances where the overall sampling design was slightly modified. In Section 3.6.2, reference was made to 11 potential macro-subregions with 2 zones. The purpose of this block was to examine site patterning from the base of a major mountain to the valley center (cross-section). Zone 1 encompasses the same area as subregions 9 and was sampled at the same percent of inventory; Zone 2 is the same subregion as Valley Bottom Center (Subregion 1). The Phase 2 sample universe totaled 2413 square miles. Within this sample universe, 47 transects were sampled resulting in a 0.25 percent coverage; 13 of the 47 transects contained one or more sites. The overall Phase 2 ratio when compared to Stage 1 is an improvement, as was expected given Phase 2 orientation and direction.

	% of Coverage	R_1 % of Tran- With Sites to Total Transects	R_2 # of Sites to Transects
Phase 1, Stage 1	0.24	0.22	0.34
Phase 2	0.25	0.28	0.53

Table 3-13

STAGE 2: DISTRIBUTION OF SITES BY SUBREGIONAL TYPE

Subregional Type	Area in sq. miles	% of Area	# of Units Sampled	# of Tran-sects	% of Coverage	# of Tran-sects With Sites	Site Distribution					# of Sites
							0	1	2	3	4	
Intermountain Catchments	160	6.6	3	11	.86	4	7	2		2		8
Mountain/Colorado River	39	1.6	1	3	.96	2	1		2			4
Mountain/Dune/Playa	236	9.8	2	6	.32	1	5	1				1
Minor Mountain	1058	43.9	4	12	.14	4	8	3			1	7
Major Mountain	512 (866)	21.2 (35.9)	2 (4)	6 (15)	.09 (.22)	2	4		1	1		5
Macro-Subregional *Zone 1	354	14.7	2	9	2.1	0	9					0
Macro-Subregional *Zone 2	54	2.2	2	7	1.6	1	6	1				1
TOTAL:	2413	100.	16	54	.28	14	40	7	3	3	1	26

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* = Sampled only - does not include potential areas (see explanation).
()= If Macro Zone 1 is included in Major Mountain figures.

Although only slight improvement was noted for R_1, the ratio of transects with one or more sites (presence/absence) to total transects; whereas, R_2, a more accurate reflector of site density, was substantially improved in Phase 2. R_2, the ratio of total number of sites by total transects, appeared to confirm Stage 1 analysis with respect to site location and density, which was the basis for Phase 2 sampling design.

The R_1 ratio for each subregion is presented in a manner similar to what was presented in Stage 1 for each stratum (Table 3-14). In addition, another ratio (R_3), which is the success ratio, is provided. The success ratio was calculated using nonisolate sites and represents simply the presence/absence of sites within any given subregional block. This results in a particular unit's (block's) catchment viability. As used here, catchment refers to the collection of resources not just water. For instance, if only one transect had one nonisolate site in a given subregional block, then it was assumed that within that block or within its catchment there was some resource or combination of resources directly affecting site presence. Also, when considered in tandem, the R_1 and R_3 ratios measure the degree of dispersion or clustering of sites within and between blocks. Thus if only R_1 differences were examined, the results would be somewhat deceptive given the sampling design purposes. For example, in comparing minor mountain and major mountain subregional types (R_1) it would appear as though minor mountain transects are twice as successful as major mountain transects. The deceptive factor is that all of the minor mountain transects with sites are within one block as can be seen in R_3; in contrast, two of the four major mountain blocks contained sites. Table 3-14 is an example where dispersion may be more important than density and can therefore be demonstrated.

Table 3-14

Subregional Blocks to Transects and Sites
(Success Ratio)

	# of Transects	# of Transects With Sites	R_1	# of Units	# of Units With Sites	R_3
Intermountain Catchments	11	4	0.36	3	3	1.00
Mountain/Colorado River	3	2	0.67	1	1	1.00
Mountain/Dune/Playa	6	0	0.00	2	0	0.00
Minor Mountain	12	3	0.25	4	1	0.25
Major Mountain	15	2	0.13	4	2	0.50
TOTAL:	47	11	0.23	14	7	0.50

In examining the blocks sampled for Intermountain Catchment and Mountain/Colorado River subregions, each produced at least one nonisolate site (R_3). In R_1, the Mountain/Colorado type resulted in nearly twice as many transects with nonisolate sites. This suggests that between the given subregional blocks, the transect's success differed substantially; such that the Mountain/Colorado River subregion would be expected to have a higher density of sites, given a relatively equivalent R_2 value. The mere fact that differential distribution is observed between subregional blocks is of little value unless plausible explanation for the observed variance is posed. In the previous section, the dichotomy of variables affecting immediate site location versus the more general catchment variables affecting areal site density and distribution was suggested. In Stage 1 analysis, primarily the former was considered, though the latter was in evidence. The possible factors could not be isolated. In this analysis, catchment related variables (vis-a-vis resources) take predominance through the examination of intersubregional variability. The immediate factors for intrasubregional variability will be given a lower priority.

In Phase 2, additional potential water resource factors besides springs, were delineated and sampled using the catchment approach. These additional water resource areas are intermountain catchments (valleys) and the Mountain/Colorado River; in each instance, the subregional type was differentiated based on known influence. Assuming that water resources are a critical factor in determining site location, then it should be possible to test this assumption by collapsing Table 3-14 into water resource and non-water resource subregional types adding nonisolate sites and testing for R_3. The following Fisher's exact test results from this data.

		Sites in Unit			
		P*	A*		
Intermountain/ Colorado River	P*	4	0	4	
Other Types	A*	3	7	10	p=.035
		7	7	14	

*P = Present A = Absent

As the final probability $p=0.035 < pa=0.10$, an association between sites and water resource related subregion can be posed. It should also be noted that the additional water resource subregions contained 30 percent of the transects and produced 48 percent of all sites within the 3-mile zone. Though the Intermountain Catchment and the Mountain/Colorado River subregions can be differentiated from the other subregionals by water resource influence, the particular water resource type is obviously different for each.

The Mountain/Colorado River subregion is certainly a special and unique area when compared to the remainder of the study area. The close proximity to a large and permanent source of water along with ethnographic information colloborate this area's high observed archaeological potential.

Based on data from the three transects sampled within the Mountain/Colorado River subregion, the sampled block appears to be relatively homogeneous and minimal intrasubregional site variability occurs. This subregion is predominately comprised of alluvial fans in varying degrees of dissection. The parent material in this area is Pleistocene nonmarine sedimentary and metasedimentary rock. Desert pavement was located within all of the transects surveyed as were the dominant and subdominant vegetations of creosote and small wash catclaw. Only one of the three transects did not contain a site (RS-139). The limited sample size restricts what can be definitely inferred about this observation, but it is possible that social, not natural environmental factors, can be suggested to explain the site patterning. As discussed by Plog and Hill (1971:12-15), one would expect sites to be located "so as to minimize the cost of resource and information flow between sites occupied by interacting populations." Furthermore, these flows have associated costs that depend on the distances and difficulty of movement and transport between and among sites. The flow between sites here refers to the ethnographically-documented trail networks which begin at the Colorado River (Needles area?) and channel through the Eagle Pass area (Sacramento Mountains). Both transects which contained sites were also in close proximity to a trail, whereas the transect without sites was not near a trail.

Comparatively, the Intermountain Catchment subregion (5) possess a more generalized water resource phenomenon. In delineating these intermountain subregion blocks no precise water source was identified. Instead, it was assumed that these regions would retain a sufficient quantity of runoff to provide not only sources of potentially recoverable water, but also to support a relatively higher biomass with respect to flora and faunal resources. Another unique feature of these units was their proximity to known spring locations. The mean and standard deviation for transects within these subregions and for the total Phase 2 sample are respectively 4.1 and 1.5 kilometers and 12.9 and 10.4 kilometers. Thus, the proximity to known spring locations is supportive of the more available water concept for this subregion.

The Intermountain Catchment blocks account for nearly one-third of all sites with an expenditure of only one-fourth of the total Phase 2 transects. Each of the three blocks sampled contained at least one nonisolate site; there are differences in site type, number of sites and immediate site location between these blocks. The Turtle Mountain block contained two temporary camps, two lithic scatters, and two rock alignments; the Old Woman Mountain block contained one temporary camp; and the Eagle Mountain block contained a rock ring. Given the level of sampling and specificity of data, few common denominators can be noted. However, as with Stage 1 results, an association exists here between desert pavement and sites, as can be seen in the following chi square.

		Sites in Transect			
		P*	A*		
Desert Pavement	Present	3	1	4	
	Absent	1	6	7	p=0.088
		4	7	11	

*P = Present A = Absent

Examining the distribution of desert pavement within the intermountain catchments in comparison to other variables, such as landform and geology, no distinct patterning or association could be found. Similarly, definitive correlations between dominant and/or subdominant vegetation and sites were absent, except that it was noted that all intermountain blocks contained cactus/yucca and creosote. The former is often hypothesized to have a high resource value; aboriginal uses for these plants can be found in Section 2.

With respect to the comparative number of sites, it is noted that the Turtle Mountain catchment block had a substantially higher site return per transect for which social and/or environmental variables provide plausible explanations. First, the block was located near the well-documented village of Mopah where previous high amounts of activity (i.e. trails, temporary camps and lithics) should be represented in the archaeological record. Secondly, the block was in close proximity to a spring and third, the Turtle Mountain catchment was nearly twice as large as the next closest catchment sampled.

Thus far, only water resource factors have been analyzed from the catchment (resource) perspective. Further analyses performed with the remaining series of potential resource-related variables, selected and quantified for such purposes, proved negative. Having exhausted the existing transect and site data potential without accounting for a substantial portion of the observed differential spatial distribution for subregional blocks, with and without sites, it became obvious that some significant variable or variables had yet to be identified. Four of the subregional blocks have been linked to water resource factors as significant determinants of site location. No plausible explanatory mechanism has been ascribed to the remaining ten blocks. The ten remaining blocks indicate: two Mountain/Dune/Playa blocks, sampled with six transects resulting in no nonisolate sites; four Minor Mountain blocks in which one block in the Bristol mountain area had sites in all transects; four Major Mountain blocks in which two of the blocks contained sites. The predominant site type within these ten blocks was lithic scatter.

In attempting to isolate other causes of differential site location, it is necessary to consider not only spatial but formal variability, the latter being the number and types of artifacts. As mentioned the majority of sites were lithic scatters, a rather general site type classification, purely descriptive in denotation, meaning only that flaked lithics occur. From the field data collected on lithic sites, functional or subsistence-settlement classifications cannot be inferred. Given in-field knowledge and experience of these lithic scatters and their environmental context, indicates that within the lithic scatter classification there is, in fact, substantial variability and thus possible causes for variability.

One particularly noticeable correlation exists between the presence of desert pavement (a site preservation mechanism), the composition of the desert pavement, and site formal variability. This correlation was the availability of good quality lithic material, possessing conchoidal characteristics occurring in the desert pavement matrix as well as the located lithic sites. However, data from the field relative to desert pavement composition was not recorded and quantified, and therefore this observation could not be tested in this manner. Geologic composition was recorded from a geologic map (Jenkins 1966), and since sites are situated on the gently sloping alluvial fans, desert pavement (the immediate source) and parent material (direct source) of lithic materials could be generalized. Thus, by determining the geologic composition of a given mountain range it is possible to test the relevance of each remaining subregional block's lithic resource "catchment" or availability. In determining the presence/absence of lithic resources two criteria must be met. First, the geologic classification must be one which contains potentially good quality lithic material. These materials were identified as Tertiary volcanics to recent volcanics and metamorphosed limestone either Precretaceous or Paleozoic, as shown on the Geologic Map of California (Jenkins 1966). Second, the subregional block and placement of transect within the block must be such that it would be possible for the potential lithic material to have been transported to the block and transect areas. This determination was made by noting the potential lithic material area on the 1:250,000 geologic map of California (Jenkins 1966) and following the existing contours toward the lower elevations of the blocks and transects. The following is Fisher's exact test conducted for the presence of potential lithic material to the presence of lithic sites.

		Sites With Flaked Lithics in Block			
		P*	A*		
Potential Lithic Material in Block (Catchment)	Present	4	0	4	
	Absent	2	8	10	p=0.015
		6	8	14	

*P = Present   A = Absent

The Fisher's exact test indicates that a significant association exists: $p=0.015 < pa=0.10$. It is interesting to note the similarities between this test and that previously discussed for water resources. The results of both tests would have been exactly the same had it not been for the loss of one positive subregional block (this being an intermountain catchment which contained a rock ring but no flaked lithics). This is an important point - the similarity is not spurious in origin, but related to the interaction of the two dependent variables. These are the presence or absence of water resource factors and lithic resources (see Table 3-15 for a general summary of the previously discussed data).

Note that for all nonisolate sites, irregardless of the occurrence of flaked lithics, where water resource factors do not account for site presence (blocks E, F, and I), lithic resources do; the converse is seen in blocks B, C, and D. It cannot, however, be argued that dependent variability is mutually exclusive, since block A is positive with respect to both variables, nor should this be necessarily expected. Site location is considerably more complex, and the results of the interaction of many natural and social environmental factors are, for the most part, unattainable given the percent of sampling and the availability of data.

Variables affecting immediate site location are the same as found in Stage 1 analysis, except for the intermountain subregionals. Distance to mountain base is generally controlled for via Phase 2's three-mile zonation criteria.

In examining the relationship of desert pavement to all Phase 2 sites, a significant association was again found (Table 3-16), although this time phi (the statistical measure of the strength of association) is somewhat weaker. This was expected since subregional units are comprised of: 1) Stage 1 Mountain/Valley Bottom stratype, for which no association existed; 2) portions of the Valley Bottom stratype in which an association did exist. The following table is based on all 54 transects and site types, as with Stage 1, isolate sites are included.

Table 3-15

SUBREGIONAL BLOCKS TO PRESENCE OR ABSENCE OF RESOURCES

Subregional Type		Sites	Water Resources	Lithic Resources	Sites With Flaked Lithics
Intermtn. Units	A	+	+	+	+
	B	+	+	-	+
	C	+	+	-	-
Mtn/Colorado Unit	D	+	+	-	+
Major Mtn Units	E	+	-	+	+
	F	+	-	+	+
	G	-	-	-	-
	H	-	-	-	-
Minor Mtn Units	I	+	-	+	+
	J	-	-	-	-
	K	-	-	-	-
	L	-	-	-	-
Mtn/Dune/Playa Units	M	-	-	-	-
	N	-	-	-	-

+ = presence

- = absence

Table 3-16

Sites in Transect

		P*	A*	
Desert Pavement	Present	11	11	22
	Absent	3	29	32
		14	40	54

*P = Present A = Absent

$$X_c^2 = 6.65$$

(Note, with one degree of freedom, an x^2 value of 2.70 or greater is needed at the .10 significance level)

In two of the three instances where sites were present and desert pavement was absent isolates existed. Transect SS-101 contained an isolated point and transect DS-110 contained an isolated ceramic sherd. The third instance was a temporary camp located near the mountain base where desert pavement is not considered a primary determinant. Desert pavement again appears to be an important factor in site preservation, contingent upon its lithologic composition and site location.

Given the previous information, it is possible to evaluate the two macro-subregional blocks (Subregions 10 and 11) and present plausible arguments concerning their relative paucity of sites. As previously mentioned, these subregions contained two zones and extended from a major mountain base to the valley center. The extension past three miles from mountain base is termed Zone 2. A lithic scatter within Zone 2 of the Old Woman Mountains macro-subregional block was the only site discovered in the 16 transects expended within these blocks. Arguments supporting the paucity of sites within these two blocks are: 1) neither of the macro blocks contained lithic resources; 2) neither of the blocks could be considered affected by positive water resource factors; 3) Zone 2 of each block, as based on Stage 1 results, was expected to have a lower overall density of sites; and 4) the site located was near a small hill (Mountain/Valley Bottom stratype) which is a more likely area for sites to occur.

With implementation of the subregional block approach it was assumed that modifications in Stage 1 sampling strategy would result in an overall "better return," both pragmatically and theoretically. Although operationally difficult, Phase 2 was truly of a multistage design and origin. Through the Phase 2 design, an attempt was made to isolate, elaborate upon and operationalize, the observed and hypothesized sources of variability, potentially affecting site location; but, is this design really any better than Stage 1? To answer this question, it is necessary to evaluate the validity and efficacy of the subregional approach and, specifically, its classificatory distinctions (subregions)(this is also discussed in Comprehensive Analysis).

Above all, the subregional design should be considered a significant and relevant contribution to the sampling strategy because it improved and supported Stage 1 data in two ways. First, we can propose and then confirm the empirical validity of areas where water resources, in addition to springs, should be taken into consideration. Second, the implementation of block sampling and analysis provided the means to operationalize a generalized catchment (resource) perspective and control the normally wide dispersion of transects as necessitated by the Stage 1 design.

Analysis of Phase 2 data indicates that of the seven subregional types, the intermountain catchments and the Mountain/Colorado River types deserve differentiation as areas possessing distinct systematic probabilities for site location. The other subregions, with the exception of Macro Zone 2, should at this point remain undifferentiated as a total unit.

3.7 Comprehensive Analyses

3.7.1 Site Preservation

Differential site preservation can make a significant difference in predictive analysis unless its causes can be isolated and effects controlled by defining the relationship between this noncultural formation process and the resultant post depositional change ("N-transform"). It was proposed in the foregoing Stage 1 analysis that desert pavement could be considered the primary mechanism or vehicle for site preservation. Phase 2 data further confirmed this proposition, and in conjunction with Stage 1 data, results in the following test.

		Sites in Transect			
		P*	A*		
Desert Pavement in Transect	Present	25	29	54	
	Absent	5	73	78	X^2=289.00
					Total Stage 1 and Phase 2 Transects
		30	102	132	

*P = Presence A = Absence

From the table above, a significant association exists between the presence of desert pavement and sites and conversely the absence of both. If it is assumed, as posited, that this is the result of differential preservation probabilities and not simply cultural selection, then it is necessary to identify those situations where preservation is possible before culturally relevant variability may be considered. In order to do this it is necessary to examine the differential distribution of desert pavement.

Unfortunately, no readily available "desert pavement map" exists analogous to those prepared for topography, geology, etc. Nevertheless, a crude approximation can be accomplished using existing transect data wherein plausibly related variables such as landform and geology are considered. Only Stage 1 data are used as the sampling design and, thus, resulting spatial distribution of transects guarantees roughly equivalent observation throughout the entire study area. As with all transects, landform data were recorded for each quarter within the transect. The data were based on Brenner's landform study (1978) and obtained from a 1:250,000 scale overlay upon which each transect was located. Table 3-17 summarizes the distribution of transect quarters by landform and presence/absence of desert pavement. (Note that only somewhat greater than 10 percent of the quarters could be definitely ascribed as containing desert pavement whereas in previous analysis 40 percent of the transects possessed pavement.) This apparent discrepancy results from the fact that presence/absence of desert pavement refers to the transect as a whole, not specifically to which quarter or quarters the phenomenon was observed. To resolve this, when desert pavement was denoted as present one of each mutually exclusive landform type was counted (see Appendix B), with the exception that when a site also occurred within the transect, the data was taken from Appendix C to resolve the question.

As is expected, desert pavement is totally absent from the mountainous regions which includes those areas classified as pure Mountain and pure Pinyon/Juniper by the "stratype" typology. However, there are two landforms possessing desert pavement which by Brenner's classification have slopes ranging from 10-30 percent and 30-90 percent (i.e. the pediment and hill types, respectively), which, given expectations, seems somewhat incongruous. Uncertainty exists as to whether desert pavement actually occurs under these situations or whether problems exist with the data, either by lack of specificity, or simply incorrect recordation. Irregardless, 69 percent of all instances of desert pavement occur on alluvial fans though only 57 percent of the entire study area would be subsumed under this classification. A Spearman's rule was applied to the data from Table 3-17. Ranking by percent for both the total landform and landform containing desert pavement, it is found that r_s = .4616, which is not significant at the 0.10 level for landform type, i.e. the first level of differentiation. This indicates that there is no substantial correlation between landform type and desert pavement. The presence of desert pavement within the Sand Dune, Playa and Lava flow categories, can be explained as either special or exceptional cases. Both the Amboy Lava and Bristol Playa desert pavements are not what one would consider "classic" desert pavement formations; the former is a relatively recent phenomena while the latter is associated with the former, as the Amboy Crater created a pavement of recent volcanic material upon the northwest end of Bristol Playa. The nature of desert pavements within sand dunes likewise suggests special consideration, as the continually shifting sands can either bury or exhume existing desert pavements. The remaining types are the Alluvian Fan, Hill and Pediment which comprise 74 percent of the study area's landform variability and account for 88.88 percent of all desert pavement. Within each of these landform types, the approximate percentage composition of desert pavement has been calculated and is shown in Table 3-17. Note, that while these types represent 74 percent of the total area (Column V_1), only 13.85 percent can be definitively ascribed as possessing desert pavement. Thus, it is presumed that within

Table 3-17

LANDFORM TYPE BY QUARTER TO PRESENCE/ABSENCE OF DESERT PAVEMENT

Landform Type	Landform Sub-Type	Code	V_1 Total # of Quarters	V_2 Rank By Landform Type	V_3 # of Quarters With Desert Pavement	V_4 % of Land-Form Type With Pave-ment
Playa	Dry Playa	01	8 (2.56)	8	1 (-)	special case
Plein	Plains	03	4 (1.28)	11.5	0 (0.0)	0
	Sand Covered Plains	04	4 (1.28)	11.5	0 (0.0)	0
	TOTAL		[2.56]			[0.00]
Riverwash	Riverwashes	06	2 (0.64)	14.5	0 (0.0)	0
	TOTAL					[0.00]
Sand Dune	Sand Dunes	07	2 (0.64)	14.5	0 (-)	0
	Longitudinal Dunes	08	9 (2.89)	7	1 (-)	11.1
	Crescentic Dunes	09	6 (1.92)	9	0 (-)	0
	TOTAL		[5.45]			[5.88]
Alluvial Fan	Fans	11	128 (41.03)	1	17 (47.22)	13.28
	Sand Covered Fans	12	22 (7.05)	5	2 (5.55)	9.09
	Dissected Fans	13	26 (8.34)	4	4 (11.11)	15.38
	Highly Dissected Fans	15	4 (1.28)	11.5	2 (5.55)	50.00
	TOTAL		[57.70]		[69.44]	[13.98]
Pediment	Pediments	17	11 (3.53)	6	3 (8.33)	27.27
Hill	Hills	21	40 (12.82)	3	4 (11.11)	10.00
Mountain	Mountains	22	42 (13.46)	2	0 (0.0)	0
Lava Flow	Lava Flows	23	4 (1.28)	11.5	2 (-)	special case
		—	312 (100.00)		36 (88.87)	

( ) = Percent

[ ] = Total for Landform Type

Code (see Appendix B)

these categories there is some variable affecting the presence of desert pavement. The greatest variance observed is in the Alluvial Fan category and subtypes . Having dealt with and controlled for landform, other plausible explanatory factors must be considered.

Of the two possible remaining variables, slope and geology, the former is essentially measuring phenomena similar to that of landform and therefore redundant. Geologic data were obtained from a 1:250,000 scale geologic map (Jenkins 1966) using a procedure similar to that described for landform, except that where desert pavement was present, all quarters were recorded rather than just mutually exclusive cases. The Alluvial Fan category was examined first as nearly 70 percent of all desert pavement observed occurred on alluvial fans. Table 3-18 summarizes the breakdown of desert pavement by geologic deposit, controlling for only Alluvial Fan subtypes, i.e. fans, sand covered fans, dissected fans and highly dissected fans.

The internal order of the geologic deposits within Table 3-18 is arranged from more recent types to those of increasingly relatively greater antiquity, proceeding from top to bottom. Percent geologic composition ranges from a high of 63.88 percent for Quaternary alluvium to 0.00 percent for Quaternary salt deposit. It would appear probable, with certain exceptions, that the greater the antiquity of the geologic deposit, the greater the percentage of desert pavement. To statistically test this proposition, a distinction was drawn between recent Quaternary and early deposits with Qs, Qal, Qst and Ql types representing "younger" types and those from Qc-Qal to M (Precretaceous metamorphic) being the "older." The presence/absence of desert pavement on alluvial fans, taken from Table 3-17, was then divided by this criterion for relative antiquity, resulting in the following contingency table.

Presence/Absence of desert pavement

		P*	A*	
relative age of geologic deposit	"younger"	29	88	117
	"older"	46	17	63
		75	105	180

X^2=39.19
desert
pavement = 1

*P = Presence A = Absence

For the chi square value of the test above, with one degree of freedom, the association is significant beyond the 0.001 level and possesses moderate strength with phi 0.467. The association between the age of the geologic deposit and presence of desert pavement is, of course, not absolute; yet these data emphasize the necessity of controlling for the "natural" bias inherent in such samples. The remaining landform types, Hill and Pediment, were also examined and revealed similar results (the same form of association except with greater strength).

NOTE: Table 3-18 contains geology information taken from 1/8th by 1 mile sample units. Each sample unit may contain more than one geologic deposit and only the presence or absence of desert pavement. This lumping of data to presence or absence of desert pavement can suggest desert pavement to appear in unlikely geologic deposits (i.e. Precambrian rock).

Table 3-18

PERCENT OF DESERT PAVEMENT BY GEOLOGIC DEPOSIT

	Geologic Deposit	Percent of Total Deposit	Percent of Total Desert Pavement	Percent of Geologic Deposit with Desert Pavement
YOUNGER	Qs - Quaternary dune sand	0.55	0.00	0.00
	Qal - Quaternary alluvium	63.88	38.66	25.22
	Qst - Quaternary salt deposit	0.00	0.00	0.00
	Ql - Quaternary lake deposit	0.55	0.00	0.0
OLDER	Qc/Qal	5.00	12.00	100.00
	Qc - Pleistocene nonmarine	11.66	22.66	80.95
	Qp - Plio-Pleistocene nonmarine	2.22	5.33	100.00
	Tc - Tertiary nonmarine	1.11	0.00	0.00
	Tia - Tertiary intrusive	0.55	1.33	100.00
	Tv - Tertiary volcanic	2.22	5.33	100.00
	Tub - Tertiary volcanic (basalt)	0.55	1.33	100.00
	gr - Mesozoic granitic	2.22	5.33	100.00
	gr-m - Pre-Cenozoic granitic	1.11	0.00	0.00
	PEc - Precambrian rock	2.22	1.33	25.00
	PEgr - Precambrian granitic	3.88	2.66	28.57
	PEg - Precambian gneiss	1.66	4.00	100.00
	M - Precretaceous metamorphic	0.55	0.00	0.00
	TOTAL PERCENT	99.93	99.96	—

The spatial distribution of older alluvial fan deposits is quite variable though, occurring with greatest frequency and abundance around the immediate mountain base; the quantity being roughly proportional to the relative size of the mountain mass or area. Major hydrologic phenomena also seem to affect distribution in proximity of the basin center (where dry lakes occur), and major drainage systems enhance the probability of disturbance and superimposed redeposition. The end result of these and other factors is that, with few exceptions, older, relic fans rarely extend much beyond three to five miles from their respective mountain base (the major exception being the eastern side of the Turtle Mountains). Nevertheless, the issue at hand is not the definitive why and wherefore of desert pavement, but the importance of the covariance of landform/geologic type and archaeological potential and the implications for both land-use planning and predictive modeling or analysis. These are related yet different concerns. Land-use planning is almost entirely empirical in nature, with primary importance placed upon the "where" of archaeological resources; while predictive modelling focuses more upon the "why." To accurately address both objectives, an integrated methodology must be used in conjunction with explicit N-transforms functioning as conditionals.

Applying the same procedure on Phase 2 data, a highly significant association again results, as would be expected. However, since the 47 Phase 2 transects represent sampling within 3 miles of the mountain base, an area possessing a larger proportion of older sedimentary deposits (46 percent for Phase 2 versus 35 percent for Stage 1, respectively), a somewhat stronger association was anticipated than the resulting Phase 2 phi of 0.447. It is suggested that the nominal difference between the Phase 2 phi of 0.447 and Stage 1 of 0.467 is the result of: 1) different sampling strategies and the resulting dispersion of transects; and 2) the loss of a substantial number of observations for the "younger" geologic category, tending to decrease the magnitude of discrepancy between the observed and expected frequencies, the basis of chi-square and the phi statistics. If the three mile criteria is used to divide Stage 1 data, then the resulting phi value differs radically:

Stage 1: Alluvial Fan Landform Type Only

Within 3-mile Zone

		Desert Pavement			
		P*	A*		
Age of Deposit	Younger	17	44	61	$X^2 = 28.28$ Significance < 0.001 $\phi = 0.509$
	Older	38	10	48	
		55	54	109	

*P = Presence. A = Absence

Beyond 3-miles of Mountain Base

		P	A		
Age of Deposit	Younger	12	44	56	$X_c^2 = 4.48$ Significance < 0.05 $\phi = 0.251$
	Older	8	7	15	
		20	51	71	

These contingency tables demonstrate that, although strength of association decreases beyond the three-mile zone, significant associations nevertheless exist. What essentially can be inferred from these tests is that as the distance from the mountain base increases, the probability of encountering desert pavement decreases, resulting primarily from a corresponding decrease in older, less disturbed geologic deposits. The observed percentage calculations within and outside the three-mile limit, were 50.5 and 28.2 for desert pavement and 44.0 and 21.1 for older geologic deposits, respectively. It is also apparent that there exist numerous situations where desert pavement occurs on the newer, recent Quaternary deposits, and that the relative percentage of pavement remains fairly constant throughout both zones; 27.9 for within 3 miles and 21.4 for beyond.

Based on the above information, it is now possible to present an argument from which N-transform probability statements may be derived. It is a simple deductive argument involving two premises: 1) if desert pavement, then preservation - D.P. → Preservation; and 2) the type of geologic deposit and desert pavement covary - Geo $\wedge$ D.P. The first premise is tautologically valid; note, however, that the opposite would not be formally valid, Preservation → D.P., since desert pavement is not the only means of preservation. The association or covariance of geologic deposit and desert pavement, used as the second premise, has been proven statistically valid to a high degree of significance. From these premises, it can be logically concluded that an association exists between the type, or more specifically the relative age, of geological deposits and their preservation potential; an obvious enough conclusion, though necessary given the absence of precise data concerning the spatial distribution of desert pavement and the delineation thereof. It would seem as if N-transforms could be proposed at this juncture and, in all probability they can, yet two problems remain to be resolved prior to unconditional confirmation of the argument.

First, though desert pavement is not the only preservation mechanism, and this was so stated in the first premise, the argument is nevertheless contingent upon desert pavement. It will be remembered that the pavement - preservation premise was originally an outcome of an observed significant association between sites and pavement, i.e. if sites were present then preservation is tautologically true. The presence-absence of archaeological material thus became the only means of adequately adjudging conditions of preservation and, in the case previously argued, it was found that 83.3

percent of all sites occurred on desert pavement. It would seem that desert pavement alone, accounting for such a substantial proportion of the variability, would be sufficient enough to validate the previous argument, yet the question still remains as to what the nonpavement preservation conditions may be. An examination of the Stage 1 and Phase 2 data for situations where sites occurred while pavement was absent resulted in the following, summarized by site type, geology and landform:

1) isolated rock ring - Precambrian rock - mountain

2) isolated ceramic sherd - Quaternary alluvium - sand covered fan

3) isolated point - Precambrian rock - hill

4) isolated ceramic sherd - Quaternary alluvium - fan

5) temporary camp - Precambrian granitic - fan

In three of the five cases (Nos. 1, 3 and 5), the relative antiquity of the geologic deposit appears to be the relevant factor for preservation. In the cases of the isolated ceramic sherds (Nos. 2 and 4), it is doubtful that preservation should be argued given not only their geologic context and landform, but also the absence of associated artifacts.

The fact that desert pavement occurs in hill and pediment landform type contexts has been noted previously. In addition, given the above information for absence of desert pavement and site preservation, it is readily apparent that hill and pediment landform types in conjunction with certain mountain contexts are capable of preservation irregardless of the presence or absence of desert pavement. It is therefore suggested that differential preservation for hill and pediment landform types need not be addressed. Geologically, these areas are predominantly composed of Tertiary and older rock types and are confined to the Stage 1 mountain stratum. By eliminating these landform and geologic types from further analysis, the remaining areas of concern are the alluvial fans located from the immediate mountain base extending outward. These alluvial fans are comprised almost exclusively of Quaternary deposits and Tertiary nonmarine. Also, through exclusion of said geologic types, it is possible to avoid the apparent landform-geology discrepancies where, presumably, light alluvial deposits have developed over geologic formations. Preservation potential is still good as these areas are not subject to the same conditions as those on the valley bottom.

In the analysis of the remaining areas of concern, a second problem arises. Given the observed differential spatial distribution of both the pertinent geologic types and that of sites due to culturally relevant selection, it is necessary to devise some means of controlling for cultural selection with respect to geologic type. That is, it has been proposed in Stage 1 that, generally, as distance from mountain base increases, site density decreases; this was thought to be a function of cultural selection. But, as has been discussed above, there exists no uniform distribution of "old" versus "young" geologic deposits, rather as distance from mountain base increases, percent composition of the "older" deposits decreases. Therefore, is the differential distribution of sites a function of cultural factors or preservation potential? Using Stage 1 data (78 transects), and recording the transect quarters by mutually exclusive means (i.e. if three quarters were Quaternary dune sand and one quarter Quaternary alluvium then the distance from each mountain base would be recorded once for each geologic deposit), the following statistics were calculated for all Quaternary and Tertiary sedimentary and meta-sedimentary rock irregardless of distance from mountain base. As before, the younger deposits, or "Y" group, consist of recent, Quaternary dune sand (Qs), alluvium (Qal), salt deposits (Qst) and lake deposits (Ql), whereas the older, or "O" group, are the Pleistocene (Qc), Plio-Pleistocene (Qp) and Tertiary non-marine (Tc) deposits and the admixture, Qc-Qal, consisting of undifferentiated Quaternary and Pleistocene nonmarine-alluvial material):

Younger (Y) group: Min = 0.00 km
Max = 11.30 km

Distance to mountain base mean = 3.80 km
s.d.* = 2.58 km

Older (O) group: Min = 0.00 km
Max = 5.70 km

Distance to mountain base mean = 1.73 km
s.d.* = 2.02 km

*standard deviation

The above data readily points out that Y group not only extends farther beyond the mountain base, but that the overall mean distance is twice that of the O group. Yet, in a substantial number of instances as seen on the Geologic Map of California (Jenkins 1966), older deposits and younger deposits are present around the immediate mountain base. By arbitrarily limiting the distance from mountain base to three miles (4.8 km) it should be possible to equalize the O and Y ratio, since both are present within this boundary. This could also control for hypothetical cultural selection factors. Using the three-mile zonation principle, the following results:

Y group: mean = 2.25 km O group: mean = 1.36 km

s.d.* = 1.19 km s.d.* = 1.45 km

- Min and Max for both = 0.00 and 4.8 km -

*standard deviation

In arbitrarily restricting the distance, the difference between means is still present but it has been decreased. With the variability of distance minimized, it is now possible to more definitely examine the proposed preservation differences. Three measures are involved:

1) $^{S}/N$ - the total number of sites divided by number of geologic observations;

2) $^{D.P.}/N$ - ratio of desert pavement to geologic observation; and

3) $^{S}/_{N}$ $^{D.P.}/_{N}$ -a means of normalizing the site to desert pavement, and thus geology, ratio.

Y group: $^{S}/_{N} = 0.066$

$^{D.P.}/_{N} = 0.278$

$\frac{S/N}{D.P/_{N}} = 0.237$

O group: $^{S}/_{N} = 0.208$

$^{D.P.}/_{N} = 0.792$

$\frac{S/N}{D.P/_{N}} = 0.263$

The S/N ratio of sites to quantity of "O" versus "Y" type geologic deposit is found to be three times as great. Assuming that this variance cannot be accounted for by the roughly half-mile difference in sample means, then strong evidence exists for the preservation-geology hypothesis. As further corraboration, the ratios are normalized via the $^{S/N}$ D.P./N measure. Since desert pavement accounts for 83 percent of all site occurrences, by cancelling N (geologic observations) it is found that within three-miles the relative number of sites to pavement is roughly equivalent. If this is so, then the variance can only be explained as a function of geologic composition, irregardless of cultural selection.

In conclusion, differential preservation has been proven an important predictive variable in explaining site occurrence. Provided that the appropriate geologic and landform contingencies are incorporated into analysis via N-transform statements, it should be possible to eliminate the related sources of sampling error or, more general, elicit the expected differential site probabilities. Of the two, the latter seems most appropriate given the quantity of available data. Thus, while precise qualitative N-transforms would be preferable, it is sufficient at this level of analysis to derive qualitative or conditional N-transforms addressing only the relative probability for preservation potential. The transforms herein proposed ascertain only certain regions, but, given the cumulative area of these, the vast proportion of sampling universe can be assessed and also the greatest number of sites. Excluded from consideration are the "pure" mountain regions and dune-playa systems where the paucity of archaeological sites has effectively negated applicability with adequate confidence. Three discrete regions and two relative probability levels can be justifiably posed as N-transforms based on the foregoing analysis. These are: 1) the region comprised of hill, pediment, and certain mountainous landform contexts located around the immediate mountain base possesses relatively high preservation potential; 2) alluvial/sedimentary deposits of Pleistocene or greater antiquity (including the undifferentiated Quaternary-Pleistocene category) likewise possess relatively high preservation potential; while 3) the recent Quaternary alluvium, dune sands, and lake deposits must be considered to possess relatively low preservation potential.

3.7.2 Sample Characteristics and Density Estimates

In a previous study, Coombs (1978:78) noted that site frequency per sample unit data are not normally distributed and with the absence of a normal model, the commonly used parametric techniques are invalid. This is not solely a function of the site frequency distribution but also sample size. To obtain a rough estimate of the number of transects needed to use a normal model, Fisher's measure of skewness was calculated, defined by

$$G_1 = \frac{\sum(yi - \bar{Y})^3}{\sigma^3}$$

If $n > 25\ G_1^{\ 2}$ (where n = number of transects), any probability statements will be fairly valid (a 95 percent confidence probability statement will be wrong less than 69 percent of the time). Solving for G_1 above results in a value of 5.9463 and thus, more than 884 transects would be required before a normal model and the related parametric techniques could be used. Eight hundred and eighty-four transects are equivalent to a 2.76 percent sample of the study area, whereas only a 0.50 sample was undertaken in this study. Therefore, statistical techniques requiring the assumption of normality cannot be used.

The normal model is but one of many theoretical probability distributions, leaving a number of discrete distributions for possible consideration and application. Discrete distributions specify probabilities for variables which take only integer values as opposed to continuous which take real values.

The Poisson distribution was selected because in certain circumstances it can approximate both the binomial and normal distributions and because of its amenability and general versatility. In particular, the Poisson can approximate the distributions of the numbers of occurrences of events within fixed periods of time and space, or of rare events which often conform approximately to the Poisson model. In the region of the desert where this study was conducted, sites were a rare phenomena. The Poisson model provides both site density and variance estimates. Herein, sites are assumed independent given operational site definition, as provided by BLM.

Using a Poisson model in which site independence is assumed, the density estimates are as follows:

Define: X_{Ai} = the number of sites in sampled area Ai

S_i = total area of i^{th} strata in square miles

$\widehat{D}_i$ = estimate of the density of sites per square mile in the i^{th} strata

Then, $\widehat{D}_i = \dfrac{X_{Ai}}{Ai}$

and variance $\widehat{D}_i = \dfrac{\widehat{D}_i}{Ai} = \dfrac{X_{Ai}}{Ai^2}$

If one stratifies on K strata, then the estimate for the total number of sites is:

$$\widehat{D}_{total} = \sum_{i=1}^{K} Si\,\widehat{Di}$$

and the variance is given by:

$$Var \quad D_{total} = \sum_{i=1}^{k} Si^2 \quad \frac{\widehat{Di}}{Ai}$$

From stage 1 data, with k=7 strata, the following estimates are calculated:

Mtn/Hills	$\widehat{D}_1$ = 3.50 sites/mile^2	Var $\widehat{D}_1$ = 1.75 sites/mile^2
Valley Bottom	$\widehat{D}_2$ = 2.52	Var $\widehat{D}_2$ = 0.37
Dry Lakes	$\widehat{D}_3$ = *	Var $\widehat{D}_3$ = *
Dunes	$\widehat{D}_4$ = *	Var $\widehat{D}_4$ = *
Lava	$\widehat{D}_5$ = 16.00	Var $\widehat{D}_5$ = 128.0
Pinyon-Juniper	$\widehat{D}_6$ = *	Var $\widehat{D}_6$ = *
PI/Smoketree	$\widehat{D}_7$ = *	Var $\widehat{D}_7$ = *

* Due to the low percentage sample for the study, no figures are presented.

Based on these, it is possible to estimate the total number of sites:

Mtn/Hills: 2786 with standard deviation of 1053

Valley Bottom: 7178 with standard deviation of 1741

Lava: 256 with standard deviation of 181

Thus, for the sample universe, D_{total} = 10,220 sites ± 2043. A rough estimate for a 95 percent confidence interval for the total number of sites is: 10,220 ± 1.96 (2043) = 6216 to 14,224 sites, based on 78 transects or a 0.25 percent sample in which all strata were sampled minimally at the 0.25 percent level.

The chi-square test can be used to assess agreement, or goodness-of-fit, between the observed data and the theoretical Poisson model. With the Mtn/Hill stratum used as an example, the following results, where the Poisson probability function has the equation form of:

$$P\left[\bar{X}_{Ai} = x\right] = \frac{(D_1 A_1)^x e^{-(D_1 A_1)}}{x!} \qquad x = 0,1,2,3,4,5 \text{ (number of sites)}$$

Number of Sites	Actual	Predicted
1	11	10.3296
2	3	4.5200
3	2	0.9888
4	0	0.1440
5	0	0.0160

$x^2 = 1.7488$
d.f. = 4

The probability of observing a value as large as 1.7488 or larger is more than 10 percent, i.e. somewhat more than 1 chance in 10. Therefore, the null hypothesis is not rejected and it is concluded that the Poisson distribution is appropriate.

It is also possible to estimate the gain in precision due to stratification for Stage 1 (Cochran 1953:139) by a comparison between the reduction in variance for stratified versus random sampling designs, wherein only the Mtn/Hill and Valley Bottom strata are used.

Define y stratum as the average number of sites per square mile in the stratified model:

$$\text{Var (y stratum)} = \frac{\sum_{i=1}^{2}\left(\frac{Si}{3646}\right)^2 \text{Var } \bar{y}i}{Ai} - \frac{\sum_{i=1}^{2}\left(\frac{Si}{3646}\right) \text{Var } yi}{3646}$$

$$= 0.379271$$

If the transects were randomly sampled, the estimate of variance can be computed using the following:

$$\mathrm{Var}_{random} = \frac{N-n}{Nn}\left[\sum_{i=1}^{2}\left(\frac{Si}{N}\right)\mathrm{Var}\,\bar{yi} \qquad \sum_{i=1}^{2}\frac{\left(\frac{Si}{N}\right)\left(\mathrm{Var}\,\bar{yi}\right)}{Ai}\right.$$

$$+\frac{\sum\left(\frac{Si}{N}\right)^{2}\mathrm{Var}\,\bar{yi}}{Ai} + \sum\left(\frac{Si}{N}\right)\bar{yi}^{2}$$

$$\left.-\sum\left[\left(\frac{Si}{N}\right)\left(\bar{yi}\right)\right]^{2}\right]$$

where N = total area for estimation = 3646 sq. miles

n = total area in sample = 8.75 sq. miles

$\widehat{\mathrm{Var}}_{random} = 0.420612$

Thus, stratification appears to have reduced variance to 90 percent of the value for a simple random sample.

Assuming the Poisson model set forth in stage 1 analysis, in Phase 2 we have K=5 strata (subregions). The estimates are as follows:

Intermountain catchment	$\hat{D}_1 = 5.82$	$\mathrm{Var}\,\hat{D}_1 = 4.23$
Mountain Colorado River	$\hat{D}_2 = 10.67$	$\mathrm{Var}\,\hat{D}_2 = 28.44$
Mountain/Dune-Playa	$\hat{D}_3 = 1.33$	$\mathrm{Var}\,\hat{D}_3 = 1.78$
Minor Mountain	$\hat{D}_4 = 4.67$	$\mathrm{Var}\,\hat{D}_4 = 3.11$
Major Mountain	$\hat{D}_5 = 2.67$	$\mathrm{Var}\,\hat{D}_5 = 1.42$

Total number of sites:	Intermountain catchment	931 with s.d. 329
	Mountain/Colorado	416 with s.d. 208
	Mountain/Dune-Playa	315 with s.d. 315
	Minor Mountain	4937 with s.d. 1866
	Major Mountain	2309 with s.d. 1033

$\hat{D}_{total}$ = 8908 sites ± 2190 = 6,718 to 11,098 sites

The total estimates are well within expected differences. A simple test can be conducted to test the following hypothesis:

H_o: The two sampling phases are homogeneous with respect to their multiple site distributions

H_a: The two sampling phases are not homogeneous.

Applying a chi-square test of homogeneity:

No. of Sites	Phase 1 Stage 1	Phase 2
0	66	40
1	10	7
2	4	3
3 or more	2	4

$x^2 = 2.1138$
d.f. = 3

As the x^2 value is less than $x^2_3 = 6.25$, the null hypothesis cannot be rejected at the 0.10 level and it can be concluded that Phase 1, Stage 1 and Phase 2 multiple site distributions are homogeneous. The prime importance of this is realized by the reduction in area surveyed between the two phases. Stage 1 had a total population area of 4000 sq. miles, whereas Phase 2 reduced this to 2413. The estimates are consistent with one another, implying that the reduction in Phase 2 sample universe did not have an adverse effect on density estimates.

In assuming a Poisson model, note that the variance is proportional to the area of the sample considered. As the sample area increases the variation is linearly reduced such that if the area (number of transects) is doubled, the variance would be halved, provided that X_{Ai} is also doubled, i.e. $\widehat{D}_i$ remains constant.

SECTION IV

PHASE 3: PURPOSIVE INVENTORY OF SIX DRY LAKES

By Dr. Emma Lou Davis

4.1 Introduction

The purposive inventory is an investigation of the natural and cultural histories of five lake valleys - Bristol, Cadiz, Dale, Hayfield and Palen in relation to social and environmental variables. In addition to these five lakes, Ford Lake (outside of the study area) was also investigated. Locations of the lakes are shown in Figure 4-1.

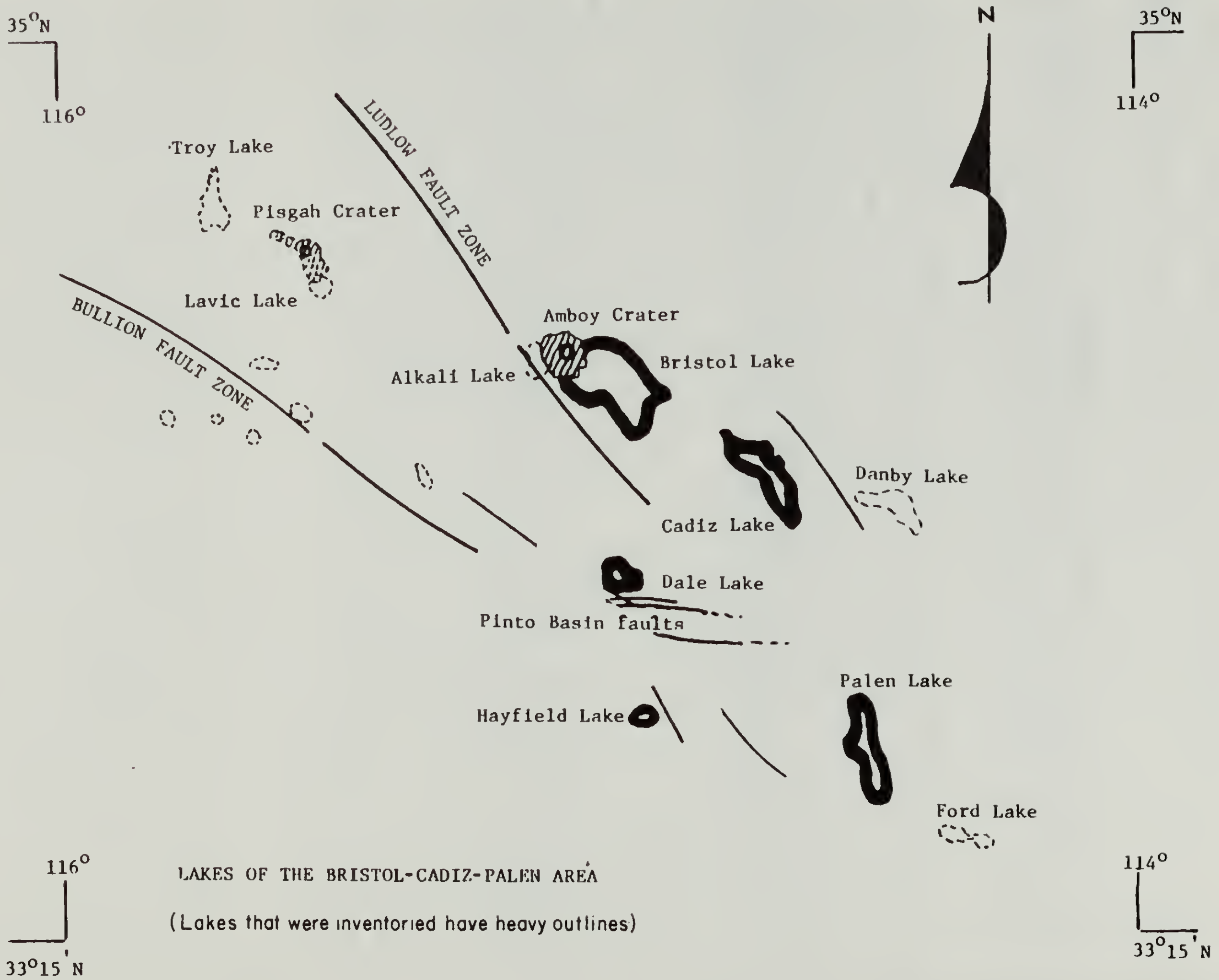
During the past 10,000 years (after California climate changed from wet/cool to warm/dry), there were many times when the lake valleys were probably not human habitats. They probably served as open roads for travel from one mountain spring to another - a life of constant travel similar to that depicted in the myths and song-cycles of recent Chemehuevis (Laird 1976). Therefore, the importance of climate and the great range of climatic changes in the lakes country is stressed. A general narrative of what this desert country looks like and how natural forces of earth and weather have worked to shape it can be found in Section 2.

4.2 Sketch of Study Area

A range of mountains is a rain-making machine with recharge capacity. Some water is stored in it, although much runs off. Fan slopes are carved by water into drainages that channel runoff floods toward a catchment basin in the valley bottom. Here, a lake forms during periods when rainfall exceeds evaporation. These periods can be discovered and charted by studying the sedimentary records of each valley lakebed. Each lake writes its own autobiography in a delicate sequence of stratigraphic layers that are different in textures. Clays record standing water; gravels were brought in by running water; sand and salt beds remain when a lake evaporates into a dry surface. Today the southern lakes are dry except for occasional flooding when the hard playas change into treacherous quagmires.

4.3 Approach

The five dry lakes, together with their shorelines and dunes, were inventoried by both probabilistic sampling and purposive inventory. Probabilistic sampling is described in Section 3 of this report. Purposive inventory accompanied and followed probabilistic sampling, building on a growing corpus of information and heuristic questions. Purposive (judgemental) transects were laid out and executed in the same manner as random ones, but were selected by nonrandom means. Selection of the 18 purposive transects was guided by the previous experience, growing knowledge and field-generated problems of the archaeologist-in-charge. Pure chance, however, was also a factor, since much of the success of a desert archaeologist is dependent upon an open mind and on watchfullness for the unexpected.



Lakes of the Bristol-Cadiz-Palen area

FIGURE 4-1

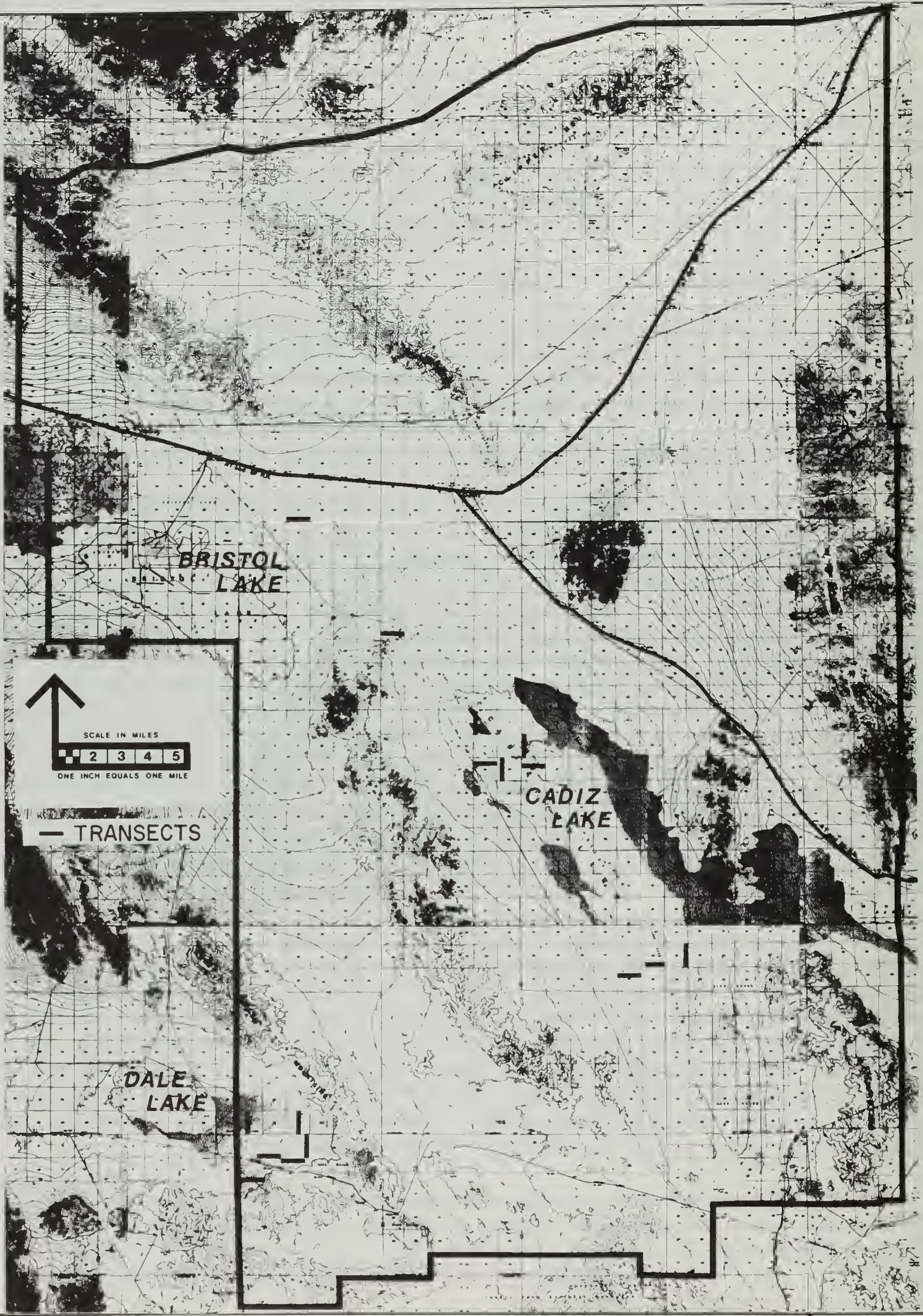
The transects and inspection procedures followed a standard format and results were recorded on highly detailed standard sheets, thus making information from all parts of the study area generally comparable (see Section 3.4). Survey of each transect along with an inspection of the lakeshores and associated dunes, was made on foot and partly with the aid of a Honda ATC tricycle (All Terrain Carrier). Purposive inventory was concentrated within or near subregion 2 of Phase 2 sample universe (see Figures 4-2 and 4-3 for area inventoried and location of purposive transects).

4.4 Geoarchaeology of Five Dry Lakes

Water has periodically transformed this desert landscape in the past and will probably do so again, far beyond our own lifespan. These changes are inferred from observations made during the fieldwork. Archaeological sites were located around the dry lakes in waterless, barren places where no native Americans would live today. The ancient sites, together with fossil sand dunes and fossil soils related to them, were studied to reconstruct portions of the prehistoric inhabitants' way of life.

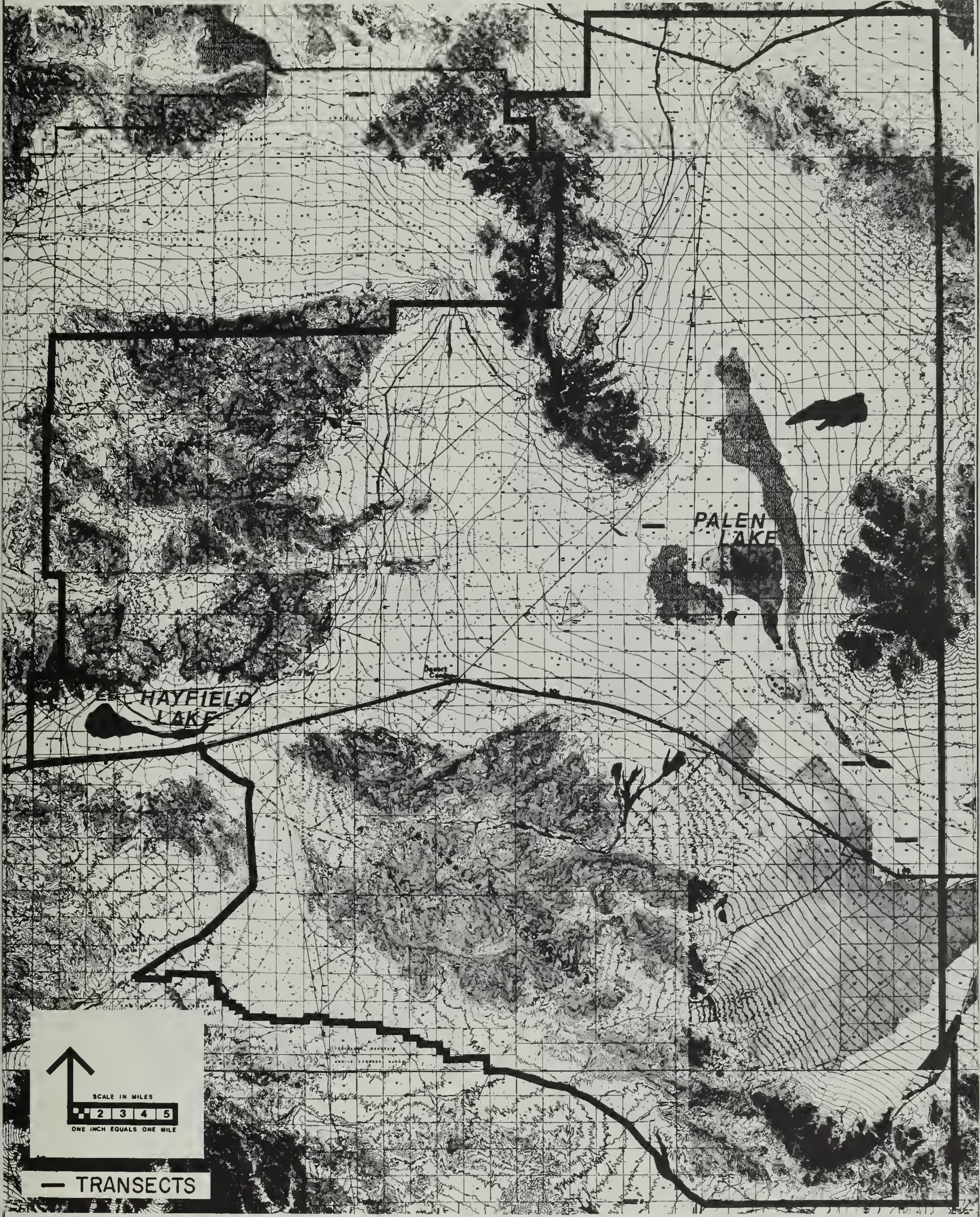
Two, possibly three, climatic intervals were favorable for lakeshore hunting and gathering. The most recent was, possibly, no more than a few hundred years ago when "Little Ice Age" rains maintained shallow lakes in Ford and Palen valleys. Evidence of another interval of shoreline camping, probably about 3000 years ago, was found beside Cadiz Lake. A site with a use interval possibly around 8000 to 8500 years ago was found in fossil dunes near Bristol Lake. There was also an inconclusive trace of human stone-work associated with a pair of caliche beds (possibly fossil soils) near Cadiz Lake; these beds may represent two moist episodes about 11,500 and 12,500 years ago. This last proposition about Pleistocene paleoclimate is extrapolated from two climatically-induced high stands of China Lake (Davis ed. 1978) in the Death Valley system (Blanc and Cleveland 1961). Some people had probably lived in the lake valley region 3000 or 4000 years ago during an interval of warm/moist climate known as the Pinto interval (Harrington 1949, 1953, 1957; Campbell 1935). Milling slabs, handstones and a number of well-known hunting artifacts distinguished sites of this interval (see Figure 4-4). People who made Pinto and Elko-eared points (Hester 1973) depended on lakeside, fresh water marshes for part of their living. Their sites contain burnt bones of birds and teeth of animals the size of mountain sheep or antelope. These people ground plant foods and pounded the carcasses of small game on milling slabs. Both plants and animals must also have been the sources of many industrial materials for daily use—reeds and rushes for mats and sandals; fiber for cordage; roots, wands and plants for basketry; hide and sinew for clothes and bindings; bones for small tools. For ancient Californians, a marsh was a general store that supplied foods and products. Marshes also supplied water to people, birds and game. Water is the life blood of deserts, and this vital relationship is written on the earth's surface when seen from an airplane or studied in an aerial photograph; the relation is shown in a drawing, Figure 4-5. Each watershed begins with mountains and ends in a catchment basin.

Climate, combined with geology and land-relationships, determines WHERE and WHEN groups of native Americans become archeologically visible in the southern Lakes Country. Cultural traditions determined how they liked to conduct their lives and how astutely they were able to adapt to the difficult, constantly changing environment. Water was the limiting factor.



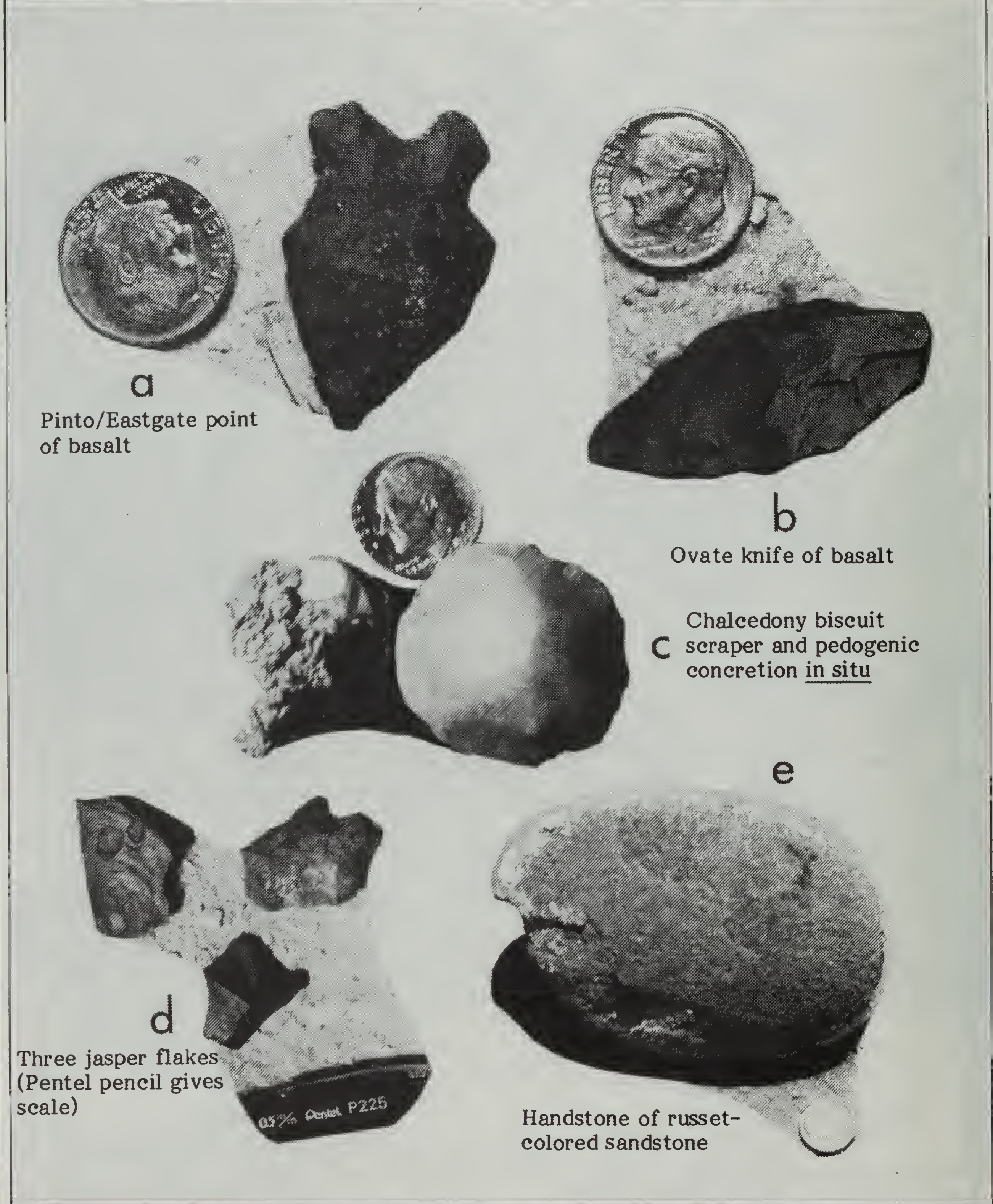
Bristol/Cadiz Planning Unit: purposive inventory of Bristol, Cadiz and Dale Dry Lakes

FIGURE 4-2



Palen Planning Unit: purposive inventory of Palen and Hayfield Dry Lakes

FIGURE 4-3



a
Pinto/Eastgate point of basalt

b
Ovate knife of basalt

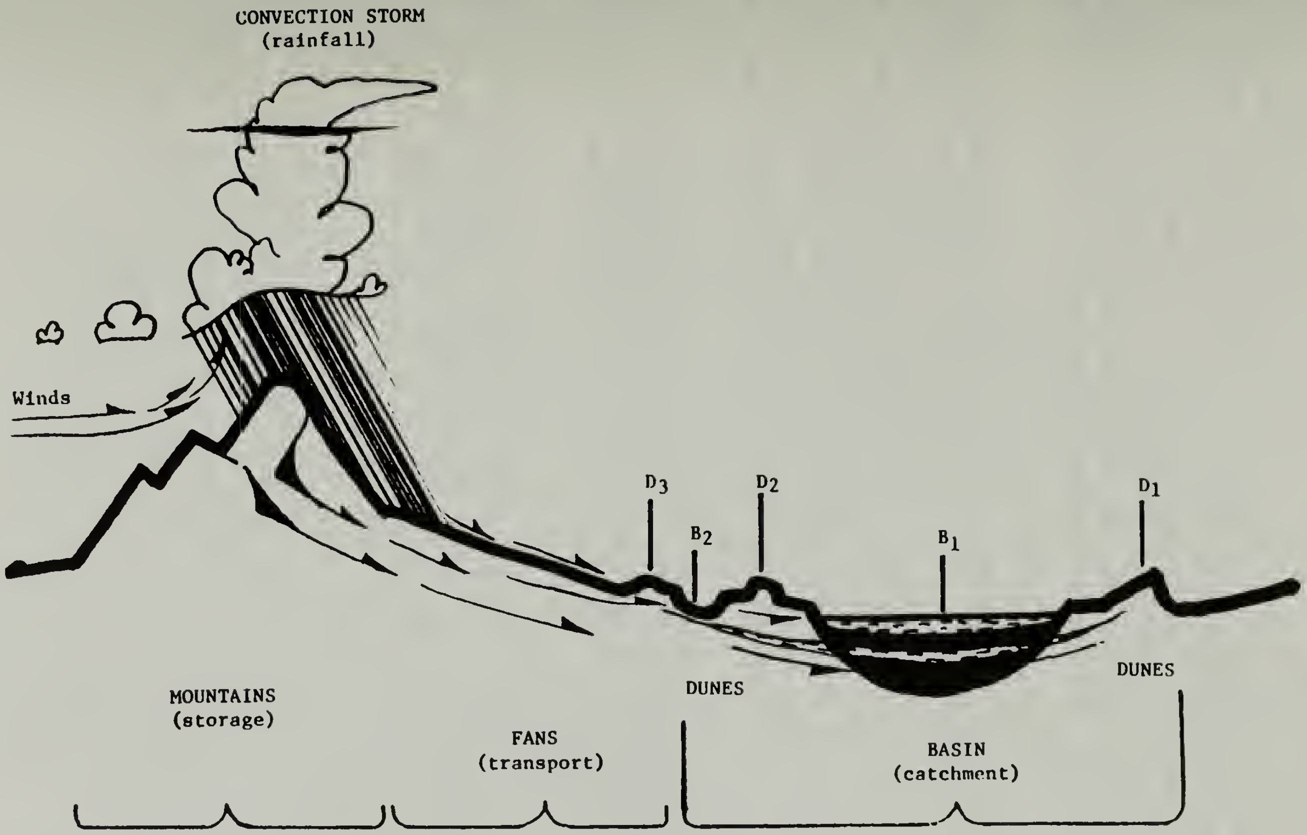
c
Chalcedony biscuit scraper and pedogenic concretion in situ

d
Three jasper flakes (Pentel pencil gives scale)

e
Handstone of russet-colored sandstone

Archaeological objects from the Cadiz Lake dunes

FIGURE 4-4



Elements of desert water budget (synergetic landscape interpretation)

FIGURE 4-5

Climate limits the water budgets available in the desert valley catchment systems. Precipitation supplies water but is counteracted by evaporation due to high temperatures. Earth, plants and animals breathe precious moisture into the hot, dry air and therefore all desert life shields itself against deadly loss of water. Human beings' special adaptation has been cultural. Native American groups developed Desert Cultures (Jennings and others 1957; Jennings and Norbeck 1964) that were fitted to a highly mobile lifestyle. People changed their residences as required: daily, seasonally or even for years, centuries and millennia. Habitation shifts in search of better water supply might be merely a move from one spring or pond to a better one or a lasting change could occur that took the little bands of collectors completely away from a drying lake to an upland valley or even to the temperate coast (Davis 1978). San Dieguito people and, later, people who spoke Shoshonean languages are examples. They probably were refugees from drought cycles in the Lakes Country.

There were other climatic intervals during which water was sufficient. Lakes and ponds returned to the basin of Bristol, Cadiz and Palen Lakes together with plants and a varied assemblage of animals including people. Sites were recorded in Palen basin that had been extensively inhabitated by hunter-gatherers who used both local and imported stone—the latter of beautiful quality—and who also used red and buffware pottery. Cadiz Lake shores were intensively exploited (in favorable places) by earlier groups who practiced a Pinto or Elko stone technology and used shaped handstones and milling slabs. This moister climatic episode was possibly 3000 to 4000 years ago (Harrington 1957). Bristol Lake dunes were inhabited during a lake-rise that may have been as much as 8000 years BP. Only a geological/climatic framework for time and environment can explain the presence of these sites or, eventually, date them. It will be possible to predict a likelihood that sites of that period will be found in the lake basins if it is learned when the water supply was increased, when soils formed, and when events of dune-building took place.

Today, rainfall is scant in the Mojave Desert and temperatures are high (see Section 2.4). Annual precipitation varies from 5.35 inches at Parker Dam on the Colorado River to 2.81 inches at El Centro (Latting 1976:130). A number of variables control the critical supply of rain, such as major and minor climatic cycles (mentioned above), local presence of mountain massifs that can either channel or block weather masses of clouds, and the directions and sources of prevailing storm tracks. Are the rain-bearing air masses arriving from polar maritime regions in the cold north or from tropical maritime regions over the southern Gulfs of Mexico and California? Polar maritime storms can be cut off by the Sierra Nevada crest, leaving deserts in a rain shadow. In contrast, tropical rains and hurricanes surge northward up the valley troughs, sometimes with dramatic intensity. As their muggy, water-laden clouds are boosted aloft by mountains and high deserts, water vapor is pushed past its dew-point and condenses explosively in prolonged downpours. Perhaps statistical prevalence of tropical storms has been a parameter in previous glacial/pluvial episodes, particularly in the Lakes Country south of Tonopah, Nevada (Don Tuohy, personal communication 1977). Differences also are found between amounts of summer and winter precipitation following a cline from the northwest to the southeast corners of the California deserts. Winter rain is more common in the northwest, while summer storms prevail in the southeast as shown in Huning (1978: 76-77) and Figure 2-3 and accompanying Station Index.

In the study area, low annual precipitation is accompanied by unusually high summer temperatures. At Palm Springs (on the west edge of the desert), the highest temperature recorded for July was 122F; and at Date Garden (Indio), 125F (Felton 1965). When fieldwork began in July 1978, the thermometer in a Desert Center gasoline station stood at 117F. It had felt even hotter in the western dunes of Palen Lake where two transects had been recorded at midday. There are new dunes of clean, golden sand like brass; blazing heat was reflected back and was felt as a pressure squeezing in from all sides. The impact of such heat on a human being is severe. Water consumption rises to several gallons a day. Eyes have to be protected by ski goggles. Loose, white clothing must shroud the entire body to conserve its envelope of moisture. Two surveyors contrived Arab burnooses out of pillow cases, bound around the head with goggle straps and flowing over the neck and shoulders as protection from an enemy sun.

Other animals conserve their moisture by living in deep, cool burrows during the day; emerging to feed only at night; and some, like the kangaroo rat, have developed a body chemistry enabling them to retain their own water, derived from dry seeds.

4.5 Individual Lakes and Their Human Records

A) The Bristol-Cadiz Chain and Dale Lake

B) The Palen-Ford Chain and Hayfield Lake

The following section will describe each lake that was visited in alphabetical order: Bristol, Cadiz, Dale, Ford, Hayfield and Palen. A standard format is used for all lake descriptions in order to facilitate comparison. This format is shown in Table 4-1. A number of considerations (see Figure 4-5) are used to place the archaeology of each lake valley in a context of Synergetic Landscape Interpretation, shown in Figure 4-6, which is applicable to all the lake valleys in the Bristol-Cadiz and Palen planning units. Figure 4-6 is derived from Figure 4-5 but shows in greater detail the different morphologies that alter the major, functional units such as mountains, or functional groups such as fan/slope/drainage complexes and dune/catchment basin complexes. The whole Synergetic System represents the recharge capacity and retention competence of each lake basin. Mountains can block or channel storms and trigger precipitation. Mountains shed part of the rainwater immediately but store much of the rest for long periods, sometimes for hundreds or thousands of years. Fan slopes and drainage gullies transport water to the lowest point in that particular landscape configuration: catchment basin complexes receive and partially retain runoff of rainwater. Amounts of water that are retained are controlled by a number of variables such as Precipitation/Evapotranspiration ratios; types of adjacent dunes; and cross sections (surface area/volume ratios). Basins with a shallow, dish-shaped cross section have lower water-retention values than do deep, bowl-shaped valleys. All lake basins observed in the Bristol-Cadiz and Palen planning units are shallow with consequent evaporation rates that are extemely high. This rapid water loss is expressed in formations of deep salt deposits (see Gale 1951). The saline beds are at present being extensively mined by a number of companies that operate in Bristol and Cadiz valleys.

Prehistoric use of the southern lakes was transitory and episodic. People had reason to visit the valley centers only when the catchment-basins retained enough

TABLE 4-1 - FORMAT FOR LAKE DESCRIPTIONS

ELEVATION OF PLAYA: ______________ m, Mean Sea Level

COORDINATES OF LAKE CENTER: _____° _____' N; _____° _____'W

RECHARGE SYSTEM FOR SYNERGETIC LANDSCAPE INTERPRETATION:

a) Mountains

b) Fans, Drainage and Paleosols

c) Catchment Basin — area, cross section, kinds of shores and kinds of dunes

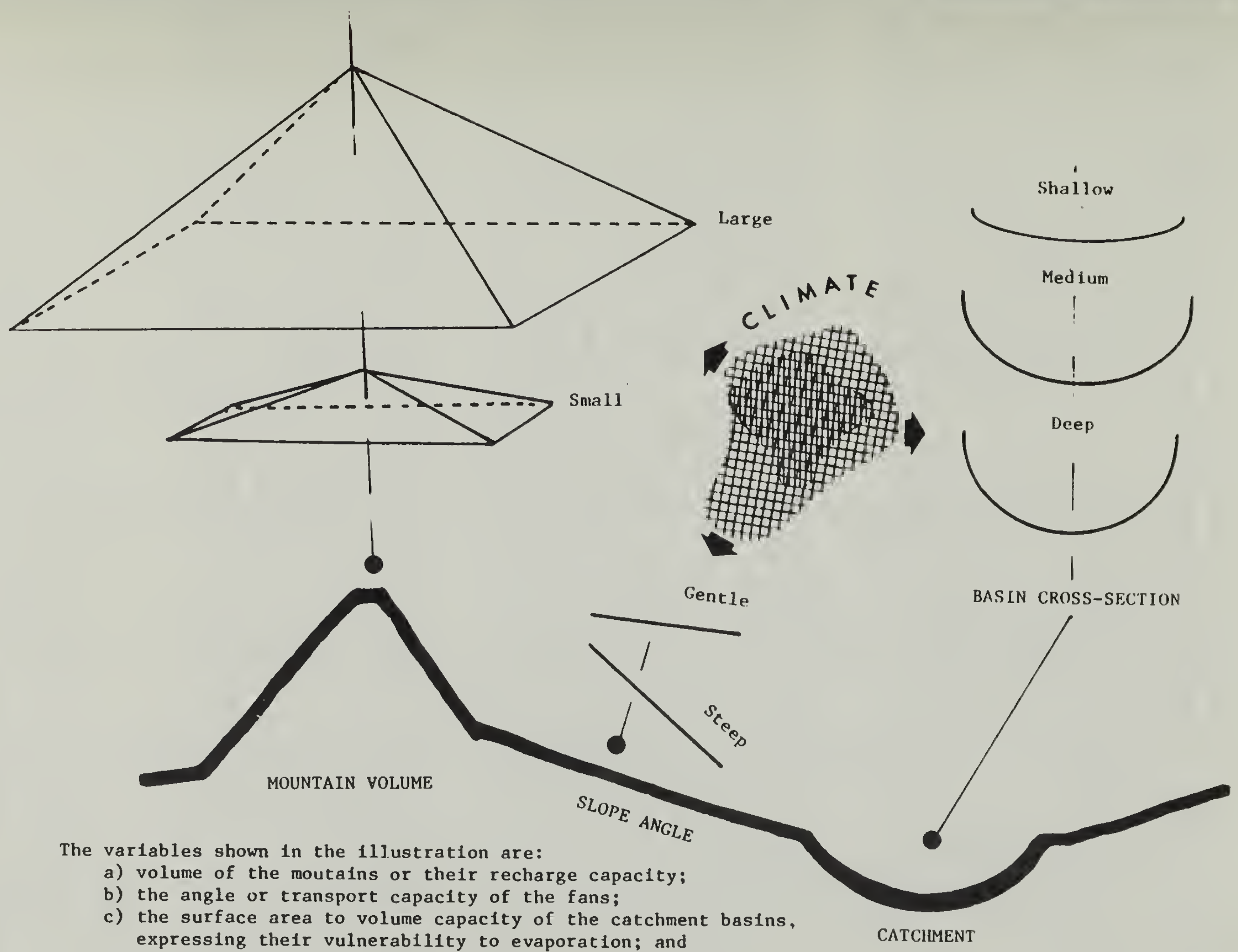
UNUSUAL FEATURES (e.g. AMBOY CRATER, ETC.):

EVIDENCES OF PAST CLIMATIC CHANGE (e.g. RESIDUAL BEDS — CADIZ AND PALEN):

ARCHEOLOGY:

a) Prehistoric

b) Historic



The variables shown in the illustration are:
- a) volume of the moutains or their recharge capacity;
- b) the angle or transport capacity of the fans;
- c) the surface area to volume capacity of the catchment basins, expressing their vulnerability to evaporation; and
- d) the critical determinant of climate.

Climate is cyclical and these cycles, once triggered, can change rapidly.

Synergetic landscape interpretation

FIGURE 4-6

water to support shoreline or inter-dune marshes. Recharge had to be six or seven times (Smith 1968, 1976) that of the present regime, in order to maintain a supply of fresh water (supported by a saline water table) in ponds among the dunes (see Section 2.5.2).

When did these episodes of lake-shore land-use occur within the far longer periods of disuse? Visible archaeological remnants around the lakes suggest that two periods of greater moisture occurred: during the "Little Ice Age" (AD 1650-1850) and during a "Pinto" climatic interval about 4300 years ago (2350 BC) (See Table 4-2). This favorable interval was suggested by Harrington (1957) at the Stahl Site, Little Lake; it may have been documented by a recent ^{14}C date on charcoal in connection with human footprints in mud near Victorville (Rector, Swenson and McManus 1978). These intriguing fossils were impressed in soft mud near cottonwoods which grew beside the Mojave River. In addition to these apparent subrecent and late Holocene use-intervals very dim clues of late Pleistocene sites (probably 11,000-12,000 years in age) were found along a shore of Cadiz Lake. The clues were a few scraps of heavily weathered jasper and chalcedony in an area where remnants of two calcic horizons of Pleistocene age are still visible.

There may well be older, Pleistocene sites in these valleys, but they would lie buried at much higher elevations in the valley. Residual lake floor remnants (Figure 4-7) in Cadiz and Palen basins show that long-standing lakes deposited bed sediments that stood as much as 2-2.5m above the present playas. These playas are later floors created first by Mid-Holocene erosion and then by subsequent, shallow flooding and the deposition of brown, silty clays. "Witness columns" of older lake floors, are shown rising out of the present clay playa in the northern part of Palen and Cadiz basin (Figure 4-8, Photo c, Figure 4-9). The older, Pleistocene lakes would have also been shallow, but far more extensive than modern playa boundaries. Therefore they must have covered two to four times their present areas and have been associated with (invisible) Pleistocene shorelines that are much higher up in the geological sections.

Climate has undoubtedly been cyclical during Holocene-Late Pleistocene intervals in the southern Lakes Country valleys, and probably reached a latest peak of cool/cold-wet/cold-dry weather during glacial/pluvial events known as the Tioga Stage in the Sierra Nevada (Blackwelder 1931; Birman 1964). During these periods, temperatures in the low-elevation, lower latitude southern Mojave Desert was likely to have been milder than in the higher and more northerly tip of the same desert that contains China Lake (Davis ed. 1978) and other Pleistocene lakes of the Death Valley System (Blanc and Cleveland 1961). Possibly the southern Lakes Country, like the California coast, (Johnson 1977 a and b) served as a refugium during times of extreme climatic stress.

4.5.1 Bristol Lake

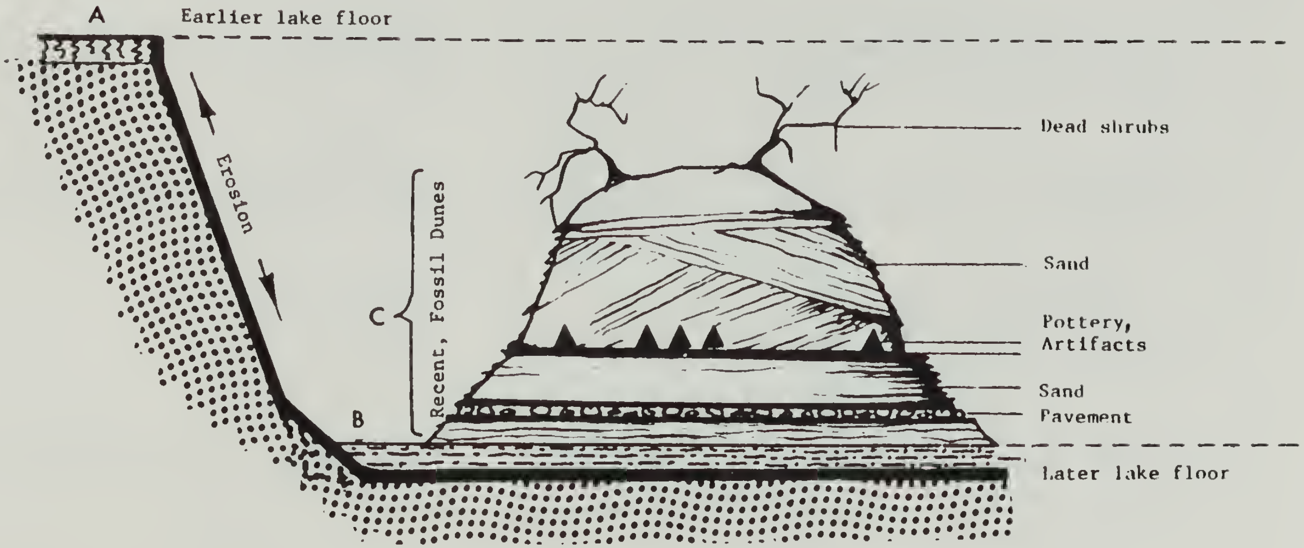
Elevation of Playa: 593 ft (180.8m); Mean Sea Level

Coordinates of Lake Center: 34° 28' N; 115° 41' W (approx.)

Recharge Systems for Synergetic Landscape Interpretation

Table 4-2 - DISTRIBUTIONS AND ESTIMATED DATES OF LAKE SITES

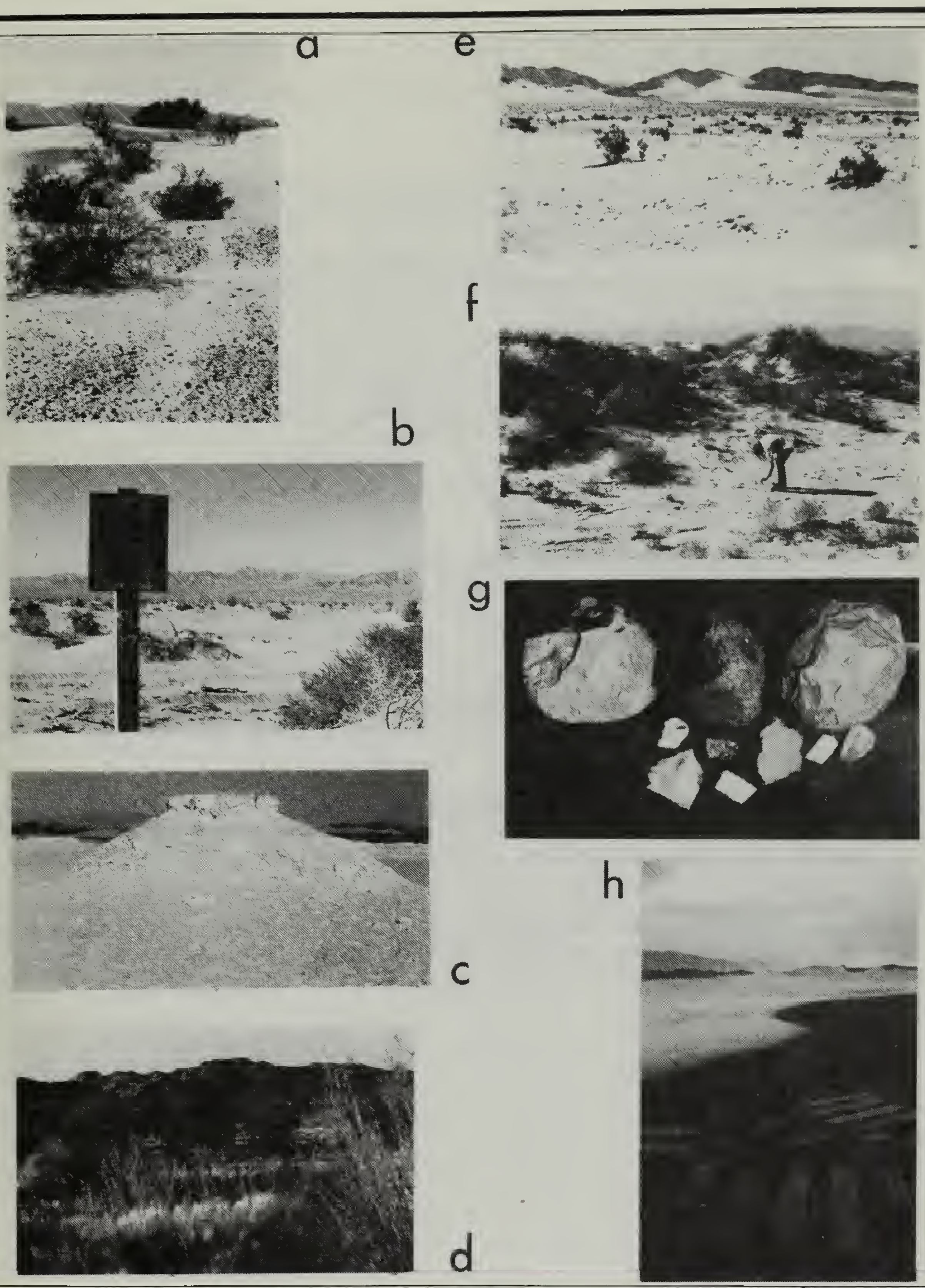
ARTIFACTS	LOCUS	LAKE	ESTIMATED GEOLOGICAL PERIOD
Hunting and Processing Tools. Red/Buff Pottery	Fossil Dunes	Palen Lake N.W.	"Little Ice Age" AD 1650-1850 (Sub-Recent)
Milling and Processing Tools Dunes	Stabilized	Bristol Lake E	Pinto lacustral - 4300 years BP (?)
Hunting	Fossil Dunes Fossil Soil	Bristol Lake E	Silver Lake lacustral episode (?) 8000 - 8500 BP (?)
Hunting, Camp Work Processing	Stabilized Dunes Fossil Soil Exposure	Cadiz Lake S.E.	Pinto lacustral - 4300 years BP (?)
Unknown and uncertain	Shore with two fossil, calcic horizons	Cadiz Lake E	Post-Tioga pedogenic intervals 11,500 BP and 12,500 BP (?)



APPARENT RELATIONS OF LAKES AND DUNES: PALEN LAKE

The north end of Palen Lake has large areas of residual sediments that stand as "witness columns" and eroding plateaus. The sediments are from one to two meters higher than the present lakebed, indicating the former presence of a deep and extensive lake, large enough to deposit the sediments. Since this older lake dried out, its bed has been eroded by wind, leaving the residual forms standing above the clay playa of a more recent lake. Dunes in this recent lakebed have formed over proto-historic sites with pottery.

FIGURE 4-7



Views of the five lake valleys

FIGURE 4-8

Key to Figure 4-8: View of the Five Lake Valleys

A) An old foot-trail crosses the pavement from lower right and disappears under a recent creasote bush and advancing dune sand at Palen Lake.

B) Post and legal document mark a mine claim about 300m northeast of the present playa of Bristol Lake; Bullion Mountains are in the background.

C) A "witness column" of white gypsum, capped with a relict paleosol (?) rises nearly 2m above the present playa of Cadiz Lake. This column is a remnant of the bed sediments of a larger and deeper lake of an as-yet unidentified lacustral interval. Dessication of the lake concentrated evaporites, which have been largely excised by wind erosion accompanied by dune-building.

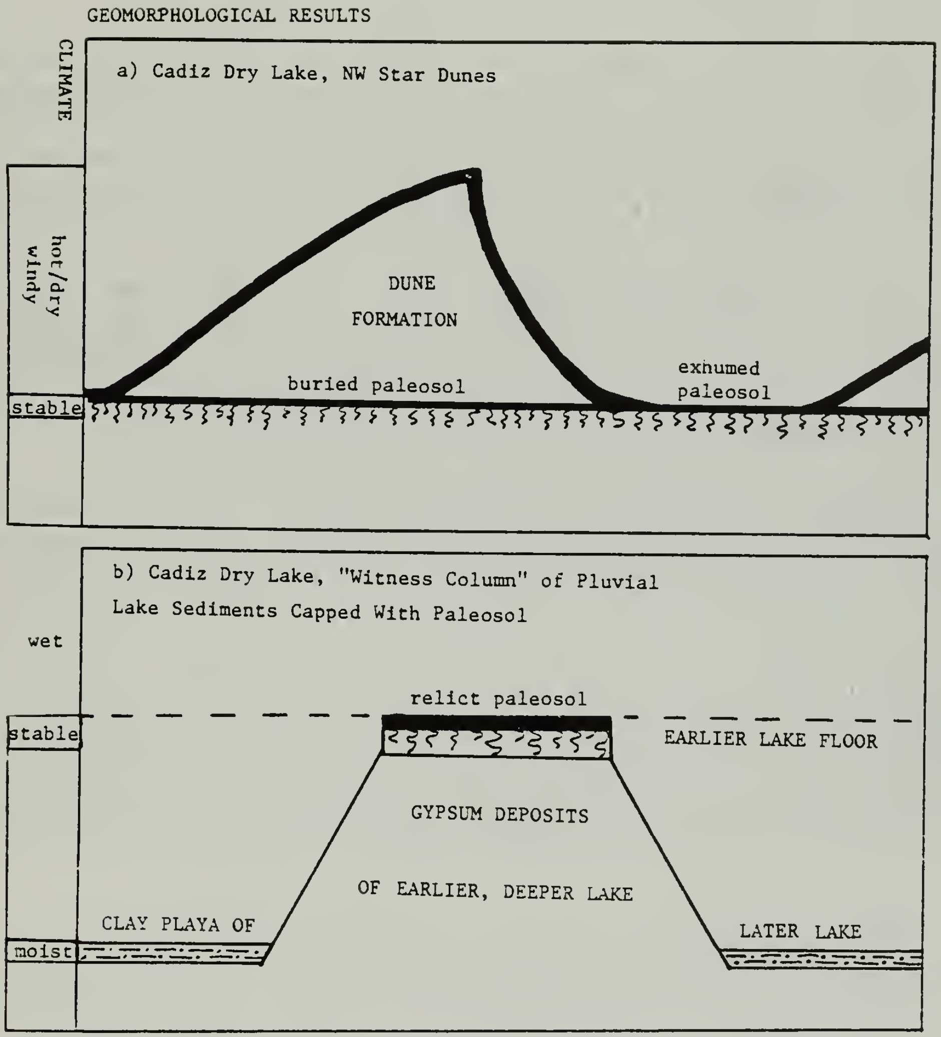
D) View southward across the north bank and overgrown basin of Hayfield Lake with Orocopia Mountains in background.

E) View looking eastward across miles of sheet sand at the east end of Dale Lake. The sand supports thriving communities of xerophytic plants and is undermined by countless burrows of vegetarian rodents. Hares ("jackrabbits") and coyotes are the largest mammals. The area seems archaeologically sterile (Sheephole Mountains are shown at top).

F) The Palen Lake fossil dunes with John Cook examining rich archaeological deposits, mixed with lag gravel that is being exposed near the base of these eroding dunes.

G) Typical archaeological remains underlying dunes of Palen Lake NW. Top row shows coarse abraders of basalt and chert. Shown on the botton are flakes of fine quality chalcedony and obsidian. A single potsherd is in the right center.

H) Aerial view looking eastward across Cadiz Lake with the dark shadow of clouds accompanying a violent sandstorm moving across the evaporation trenches of one of the salt companies. At the shadow's upper edge, a sea of growing star dunes stretches toward the Kilbeck Hills.



Some observed relations of dunes, paleosols and the playa of Cadiz Dry Lake

FIGURE 4-9

a) Mountains - Surface and underground water is supplied to Bristol Lake from all four cardinal directions out of mountains that are both close at hand (the Bristol and Calumet Mountains) and also more than 60 km distant (the Providence Mountains). When flying over the lake basin, particularly around its northern perimeter, it is easy to see the moist tracks of underground waters that surface (near the shores) in damp stands supporting healthy plant communities despite apparent drought and ferocious heat.

Other mountain storage volumes that feed water into Bristol catchment basin (see Figure 4-5) are the Old Dads; the Piute Mountains to the northeast; the western slopes of the small Calumets; the Sheepholes and Bullions provide a generous input from the south and southwest. A considerable quantity of water drains in from Alkali Lake on the west side of Amboy lava flow and from Lead Mountain along the Ludlow Fault Zone (Figure 4-1).

b) Fans, Drainages and Paleosols - Most of the Bristol water budget finds its way to the lake via intricate drainage systems cut into the gently sloping fans by surface runoff, or seeping subsurface through saturated sediments. There also seem to be clay aquifers present in places, supporting the perched water tables mentioned above. It is possible that such layers or lenses of clay are bed remnants of a much larger and deeper lake that was created by pluvial episodes of the past.

Paleosols have developed about the lakeshore and are visibly associated with archaeological sites about a mile southeast of Saltus. The paleosol at this point is a thin, cambic weathering surface scattered with tubular, pedogenic nodules similar to those related to paleosols at China Lake (Davis and Nichols 1978). These "flaggy sandstone" concretions are frequently clues to the presence of artifact-bearing horizons, partly eroded, partly buried under desert gravels. For the desert archaeologist, presence of cambic or calcic horizons is an alert — "look around." The Saltus soil horizon is overlain by sand dunes, a relationship that was also found at the north and south ends of Cadiz Lake (described later) and at Palen Lake NW. The significance of this paleosol/dune sequence is that a former climatic episode of alternate wetting and drying has been followed by a hot/dry and windy cycle (see Figure 4-9a).

c) Catchment Basin - The area of contemporary Bristol playa is about 200 km^2. This playa surface is composed of finely cracked, brown clay, overlying stratified deposits of gypsum (calcium sulphate dehydrate), halite, sands and clays described by Gale (1951:5-8 and Log of Test Hole No. 1, pg. 11). Salt is being mined extensively in the north part of the basin. The south and southwest sections of Bristol playa are impassable. The drainage from south and west, mentioned above, maintains a high water table, many square kilometers in extent. This creates a treacherous quicksand over the entire area that is readily seen from the air. Lack of foreknowledge of this condition when work began caused the acceptance of computer-generated, random transects in the bog area. A light-airplane presurvey of the whole Bristol-Cadiz and Palen area would have been an invaluable aid in planning strategies.

The cross section of Bristol Lake is extremely shallow, permitting rapid evaporation of all exposed water. Therefore, lake water during (shallow-lake) lacustrals has probably been saline or brackish. Shoreline sites would only have been attractive if special conditions existed to create interdune freshwater ponds capable of supporting marshland plant communities. Two such special settings would have been, a) major drainage brought to the surface by an aquifer (see previous page) or, b) interdune clayey sediments, deposited by rain ponds of an unusually wet period, dense enough around the edges to frame fresh water ponds floating on the surface of saline ground water. Either or both of these local anomalies may account for the extensive (though sparse) archaeological scatters in the Saltus dune.

Unusual Features

The presence of Amboy Crater surrounded by a recent flow of basaltic lava (see Geologic Map of California, Needles Sheet 1974) created an additional resource for native American transients in Bristol basin. The lava provided limited water collection after rains; chiefly it afforded rockshelters, overhangs and both stored and reflected warmth in the winter.

Evidence of Past Climatic Change

The previous section on Fans etc. and the Catchment Basin indicates that some observations were made of dune/soil/playa sequences. These relations are shown in Figures 4-7 and 4-9. Since the observations resulted from only brief, random appraisals, much more could surely be learned about past climates by combining playa trenching, dune trenching and 100 percent shoreline surveys from the playa margins to a distance of 1.5 km upslope.

Archaeology

a) Prehistoric sites: Two site areas were recorded south of Saltus. The northern area contained two camps scattered with nondiagnostic fragments of rough work tools and slabs. These objects were evidently weathering out of stabilized dunes, studded with creosote bushes (*Larrea tridentata*). The southern "site" consisted of a single, broken point made of gem-quality chalcedony. The fragment lay on a paleosol dotted with pedogenic casts and overlain by residual columns of fossil dune (Figure 4-10).

b) Historic sites: Bristol Lake is marked by salt-mine trenches in the playa and by buildings, equipment and tracks in the industrial complex of Saltus, on the south side of the Atchison, Topeka and Santa Fe railroad.

There are, in addition, at least two mine claims tacked to posts near the northeast shoreline (Figure 4-8b).

4.5.2 Cadiz Lake

Elevation of Playa: 545 ft (166.2m); Mean Sea Level

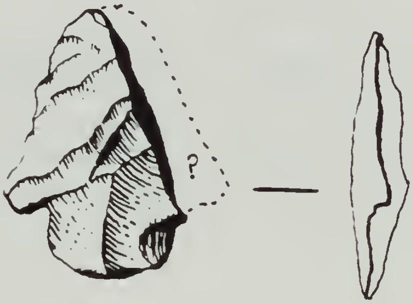
Coordinates of Lake Center: 34° 18'; 115° 1' W

Recharge Systems for Synergetic Landscape Interpretation

Transect Prefix #____________ Site #____________

WIDTH
(Flat tracing)

THICKNESS
(Edge tracing)



This is a gem-quality chalcedony, probably Ter. volcanic in source and resembling small nodules used near Amboy Crater and Palen Lake NW.

Associated with pedogenic casts typical of a period of alternate wetting and drying

MATERIAL

Obsidian
Volcanics
[✓ Crystallines]
Other

WEATHERING

Extreme
Heavy
[✓ Moderate]
Slight
None

Mid-Holocene, 4,000-6,000 yrs. BP?

Diagnostic artifact portrait

FIGURE 4-10

a) Mountains - Cadiz Lake occupies the Bristol Basin southeast of Amboy and stores the water supply from some of the mountain massifs that feed Bristol Lake. The two lakes became a single body of water whenever increases in available water raised the surface level of Bristol above 645 ft (196.7m) MSL. Cadiz is fed from the north by the Marble, Granite, Van Winkle and Clipper Mountains and from the northeast by the Piute, Old Woman and (to a very small extent) the Ship Mountains. The Kilbeck Hills may contribute more than is visible on the Needles Quadrangle Sheet (1963) due to the immediate proximity of a large dune area beneath which water can be stored, seeping at a slow rate and protected from evaporation. Other ranges in the Cadiz watershed are the Iron Mountains (southeast), the Coxcombs (south) and eastern slopes of the Calumets (west). Cadiz playa saturates quickly and only a single tropical storm in the fall is needed to make it impassable.

b) Fans, Drainages and Paleosols - Fans that encircle Cadiz Lake have gentle gradients of about 0.3 percent. Nevertheless, major water courses become deeply incised by sudden spates of water released from cloudburst storms. Pavements of volcanic rock (in places accompanied by fine quality chunks of jasper and chalcedony) spread a thin cover on some surfaces. However, no relict or water-abandoned pavements were seen and no solid mosaic pavements were encountered resembling those at the Hord Site (Davis 1973:7) near Broadwell Lake.

c) Catchment Basin - Area, cross-section, shores and dunes - The Cadiz Lake playa resembles the playas of Bristol and Palen Lakes in having a surface layer of brown clay divided by finely reticulated (about 10 x 10 cm) cracks. Area of the visible playa is approximately 93.75 km^2. It is probably far more extensive, underlying impressive areas of new dunes along the northwest and northeast corners. These dunes are predominantly of two kinds: 1) star dunes and 2) conical dunes. 1) Star dunes are active and formative. They are composed of new sand and are therefore barren of vegetation except in their marginal coves and a few interdune hollows where ponding of rainwater has allowed clays to begin depositing. The impervious clay forms a natural "planter" in which seeds can germinate and plants can root. Seen from the air, these small areas have the appearance of configurations of little gardens in the midst of the tan desert. 2) Conical dunes are quite different from star dunes in appearance and origin. They are actually produced by plants and could be called "vegidunes." When a plant succeeds in rooting in the playa, blow-sand collects in its stems. The sand conserves water which fixes more sand and harbors more plants. In this way an expanding cone grows upward sometimes reaching a height of six to eight feet. These vegidune cones are not to be confused with the residual "witness columns" of gypsum described under Unusual Features. Most shores of Cadiz are marked by dunes of different ages and aeolian histories. However, low-level shores that slope directly into the playa are visible at the southwest end of the lake and in patches along the east rim of the playa.

Unusual Features

A number of these were noted. First, star dunes of unusual extent - like seas of sand - occupy the lake's perimeter and are visible for miles. Second, small shoreline dunes overlie a weak, cambic paleosol. This soil (visible when either relict or exhumed) supports extensive mid-Holocene sites associated with Pinto/Eastgate hunting implements and milling gear. Third, there is at least one section of fossil shore surmounted by two thick beds of caliche. Fourth (and most interesting), are residual "witness columns" (Figure 4-8c and 4-9) of carbonates and gypsum and capped (in a few places) with a relict paleosol. These monuments and beds are measures of the deposits of an old lake much deeper and broader than the middle or late Holocene bodies of water. The older lakebed was almost entirely removed by Holocene erosion, leaving only a few plateaus and columns rising above more recent lakes that deposited the modern playas (see Figure 4-9b). Last, thick beds of halite and other salts buried in the lake floor have attracted mining operations by a number of different companies.

Archaeology

a) Prehistoric sites: Prehistoric archaeology that was noted in the study appears to have been restricted to a Pinto period of hunting/gathering (± 4000 years BP?) and to a faint and uncertain manifestation of much earlier use. This paleo episode is questionable and should be carefully investigated for proof or disproof. Cultural "clues" (such as they are) consist of broken and excessively weathered pieces of fine-quality exotic rock (chalcedony and jasper) that show some (nearly-obliterated) flake scars.

b) Historic sites: Historic archaeology is being made continuously by the trenching and construction of the mining companies. An early effort at mineral exploitation is evident in wreckage of an early Twentieth Century well, sluice, shacks and a wagon.

4.5.3 Dale Lake

Elevation of Playa: 1161 ft (354m): Mean Sea Level

Coordinates of Lake Center: 34° 10'; 115° 12' W

Recharge Systems for Synergetic Landscape Interpretation

a) Mountains - Dale Lake is poorly supplied with water by comparison with Bristol Lake (to the north) and Cadiz Lake (to the east). Dale Lake is surrounded by mountains that contribute most of their moisture in other directions with the exception of Valley Mountain (West Northwest) of the basin and a western section of the Pinto Mountains (West Southwest and West of the lakebed). Otherwise, the Pinto Mountains massif feeds Pinto Basin, while the Bullion Mountains (northwest) and Sheephole Mountains (eastward) are major contributors to Bristol Lake.

b) Fans, Drainages and Paleosols - Dale Lake has fans that slope gently (0-5 degrees) near the basin center, but rise steeply against the mountain base in beds of Quaternary dune sand and alluvium.

c) Catchment Basin - The area of Dale playa is small, approximately 33 km^2 in its present state. The cross section of the entire basin is extremely shallow, except for the perimeter mentioned above. This shallowness together with small area and water-capture by neighboring valleys accounts for lack of archaeological evidence in the east end of the area to which our search was confined by administrative boundaries. This east segment of Dale Lake valley is mantled by two forms of wind-blown sand deposits - sheet sand and star dunes. The extensive sandy sheets lying north of

Twentynine Palms highway are dotted with regular lines of the self-spacing creosote bushes (Larrea tridentata) that are so orderly as to resemble orchard plantings. Their deep root systems are hosts for endless colonies of burrowing rats, a few hares and an occasional coyote.

Along the northeast edge of the sand sheets, "star" dunes of new material are continually building and (probably) shifting. These large dunes are barren along their tops, but thin clay deposits in their hollows support thriving and varied communities of plants.

Fossil soils were not noted during the surveys but are undoubtedly present. However, instead of being exhumed or relict (Figure 4-9) as in Cadiz Valley, they are still buried under the endless sand deposits of Dale Lake east.

Unusual Features

Two unusual phenomena, one topographic and the other geologic, occur in the Dale Lake district. The topographic feature is a group of very large dunes with wind cornices (called "star" dunes) in the northeast corner of the valley.

The unique geologic feature of this valley is the tectonic alignment of its southern boundary—the Pinto Mountains. Figure 4-1 (a sketch of the lakes and major faults in the Bristol-Cadiz, Palen study units) shows the Pinto and Eagle mountain faults that frame northern and southern edges of the Pinto Basin just south of Dale Lake. These parallel faults (Campbell 1935, Plate 1b,c) are probably transform faults related to the San Andreas system. They evidently produced a past ecological setting that made the Pinto Basin an unusually desirable habitat for native Americans of 4000 years (?) ago. Parallel rupturing and folding along the Pinto/Eagle mountain fronts and the basin center (Geologic Map of California, Salton Sea Sheet 1967) shaped a shallow basin with a center capable of holding a lake during major pluvials (shown in Campbell 1935, Plate 2a) that was reduced to braided, meandering streams and marshes during periods of lesser rainfall. Drainage into this favorable preserve was copious from both the Pintos and Eagles as shown on USGS Pinto Basin Quadrangle, 1963.

This dove-tailing of numerous disparate pieces of evidence to reveal WHY and HOW nature created the setting of a former archaeological "find" is an illustration of the value of Synergetic Landscape Interpretation.

Evidences of Past Climatic Changes

Unusually deep gullies along valley contacts with the (small-volume) Sheephole Mountains suggests that these slopes have, in the past, received far more water than at the present.

Archaeology

No prehistoric remains were found in the eastern sectors of Dale Lake valley. However, local collectors, BLM archaeologists (and the Campbells?) have found archaeological materials in both the north and west sectors.

4.5.4 Ford Dry Lake

By accident a group of processing sites were found on the northwest shore of Ford Dry Lake. Although this basin was not officially included in the Palen Planning Unit, a trajectory from Highway 66 to the southeast end of Palen Lake obliged the survey team to cross a corner of Ford Lake. This accidental route was directly across a line of Milling Horizon processing sites. The scattered work areas were evidently on a marsh-site beach associated with a very shallow lake. Did this lake correlate with the shallow lake in NW Palen valley that was associated with rough work tools, refined hunting tools and Parker Buff pottery?

Ford Lake joined with the Palen Lakes during pluvial episodes. The Ford basin lake may have been large and rather deep. Although somewhat inventoried by BLM personnel, Ford Lake's high and intermediate shorelines should be found and explored for Paleo sites.

4.5.5 Hayfield Lake

Elevation of Playa: 1360 ft (414.6m): Above Mean Sea Level

Coordinates of Lake Center: 33° 42' N; 115° 36' W

Recharge Systems for Synergetic Landscape Interpretation

a) Mountains - Hayfield Lake is small (area: 9.38 km^2) and represents the lowest point in a narrow, W-E trending valley between Chiriaco Summit and Desert Center. Water is supplied to this valley from the Eagle Mountains (rising precipitously along the north margin) and the Orocopia massif to the south. A long fault runs along the valley center between the two settlements just mentioned.

b) Fans, Drainage and Paleosols - The fans that transport Hayfield drainages are the northern Orocopia fan complex, Cholla Wash fan and a fan that emerges from a nameless canyon just to the east of Hayfield Spring, a major contributor to its water supply. A very short time was spent on the northwest shore of Hayfield Lake and soil exposures were not noted.

Contour lines on the Hayfield, California USGS Quadrangle Sheet (1963) show that the lake has drained to the east through the 1360 ft contour. During such episodes of overflow, Hayfield water may have merged with a number of drainages out of the north end of the Chuckwallas, forming a braided stream. If this water was slowed enough to pond in places (like the braided stream in the Pinto Basin) then marshes could have formed and archaeological sites would be expectable during periods of favorable climate.

c) Catchment Basin - Area, cross-section, shores and dunes - The lakelets that formed in Hayfield Basin probably did not greatly exceed 9.4 km^2 in area. However, they may have been deeper than other southern lakes described in this report. The Eagle Mountain slopes dive steeply into the north side of Hayfield and if the lake's tendency to silt up rapidly were counteracted by occasional flooding and downcutting, then Hayfield may have had a medium depth to surface area ratio. Shores of the lake are at present occupied by small trees and thriving plants, and the playa is overgrown. No dunes were noted.

Unusual Features, Evidence of Past Climatic Changes, Archaeology

No unusual features, evidence of past climatic change or archaeological remains were encountered during the brief survey.

4.5.6 Palen Lake

Elevation of Playa: 428 ft (130.5m): Above Mean Sea Level

Coordinates of Lake Center: 34° 46' N; 115° 12' W

Recharge Systems for Synergetic Landscape Interpretation

a) Mountains - Palen Dry Lake is divided by Quaternary alluvium into a northwest and a southeast sector (Geologic Map of California, Salton Sea Sheet 1977). The two sectors are isolated by either mountains or miles of dunes, formed during the late Holocene and modern dry regime. However, the Palen Lakes have, during cycles of greater rainfall, been united with other bodies of water, including Ford Lake, that filled much of Chuckwalla Valley.

Palen Lake NW receives water mainly from the Coxcomb Mountains which abut immediately upon its northwest side. This close contact is archaeologically significant (discussed below).

Palen Lake SE is fed by the Eagles, the Palens, the Coxcombs, the Chuckwallas and (from long distance) the Orocopias.

b) Fans, Drainages and Paleosols - Fans were inspected in only two localities: the SE Coxcomb fan and the deeply dissected, SW Palen Mountains fan. The SE Coxcomb fan is covered with angular lag gravel, is moderately steep, and is moderately dissected by drainages that must have discharged directly through the shoreline archaeological sites. These sites are associated with exhumed remnants of the fan lag gravels. I assume that occasional fresh water from the fan drainages was an important part of the subsistence base of pottery-making Indians who camped along shores of what might have been predominantly brackish lakes. These sites were subsequently covered by fossil dunes which are now eroding.

Paleosol remnants (Figure 4-7) cap eroding lakebed remnants in Palen Lake NW basin and pedogenic nodules from a very weak paleosol occur under the NW dunes. As at Cadiz Lake, this weak paleosol may be associated with an archeological horizon.

Unusual Features

1) As at Cadiz Lake, eroding remnants of an older lakebed stand above the contemporary, clay playa.

2) This phenomenon (e.g. Holocene erosion of Pleistocene deposits) produces a situation of reversed stratigraphies.

3) The occurrence of eroding, fossil dunes *overlying* pottery sites suggest very rapid drying of a subrecent lake (the lake that supported pottery-making campers) accompanied by dune-building as dry sand was released. These dunes are now, in turn, being eroded.

4) Very flat fans (pediment?) covered with black, basaltic pavements emerge from canyons at the south west tip of the Palen Mountains. Incorporated in this pavement are a few surprising heavy lumps of what appears to be pure iron, patinated as black as coal.

Evidences of Past Climatic Change

The relationships of deep lake/thick sediments, erosion, shallow lake/lag gravel/archaeology land-use and then dune formation/dune erosion contain an excellent account of climatic changes over (perhaps) the past 10,500 years. These relationships merit a careful study by experts.

Archaeology

No archaeological traces were found in playa transects or in a N-S transect in the east dunes of Palen Lake NW. However, local informants stated that stone artifacts are now weathering out from under new dunes in this north basin. The productive site area among the NW dunes was also pointed out by a local collector. This rich area should be test excavated in order to confirm stratigraphic sequences, find artifacts *in situ* and date the formation. There is campfire charcoal in the sands. This work should be accompanied by adjacent coring of the lakebed in order to establish a marsh-dune sequence comparable to the Ash Meadow correlations of Mehringer and Warren (1972).

4.6 Retrospect

The inventory results were highly positive. Minuscule budgets of time and money were compensated by enormous expenditures of human interest, ingenuity and energy so that orderly, comparable bits of geoarchaeological information now exist for 2½-million acres of desert that were largely an archaeological blank. Work in an unknown lake country, at break-neck speed, in dangerous weather, pursuing unfamiliar methods of fieldwork seemed a disaster at the beginning that grew into a great adventure - an exciting education. Not often is there the opportunity to jump into discovery and get wet all over - to confront a large problem with untried tools, to learn new paths toward knowledge and to *change one's mind*. The concept of Synergetic Landscape Interpretation as a geoarchaeological guideline was only one outcome of this learning experience.

SECTION V

EXISTING RECORD AND SITE PATTERNING OBSERVATIONS

By Dennis Gallegos

5.1 Existing Record

The existing record (previously recorded sites) data was compiled from BLM site records. These records include site forms from the San Bernardino County Museum and University of California, Riverside. The first site recorded for the study area is dated 1952, and was recorded by F.J. and P.H. Johnston. Since this date, only 83 archaeological sites have been recorded in this 2½-million acre study area. Table 5-1 shows that only 10 sites were previously recorded for the Bristol/Cadiz Planning Unit (P.U.), an area of approximately 900,000 acres. The existing record for the Turtle P.U. and Palen P.U. shows a total of 73 sites. This is an exceedingly small existing record for an area with a cultural resource site projection of roughly 10,000 sites for the 2½-million acre study area. The total existing record (83 sites) represents less than 1 percent of the projected cultural resource sites. Including all 151 sites recorded in the WESTEC Services' Class II inventory, a total site inventory of less than 3 percent has been obtained.

Table 5-1

NUMBER AND PERCENT OF SITES RECORDED BY PLANNING UNIT AND SAMPLE STAGE

Planning Unit	Existing Record		Stage 1		Phase 1 Stages 2 & 3 Phase 2		Other		Total	
Bristol/Cadiz	10	(12)	13	(40)	10	(23)	30	(39)	63	(27)
Turtle	32	(39)	14	(44)	19	(44)	24	(32)	89	(38)
Palen	41	(49)	5	(16)	14	(33)	22	(29)	82	(35)
TOTAL	83	(100)	32	(100)	43	(100)	76	(100)	234	(100)

( ) Percent

Sites have been compiled in Table 5-2 by site type and type of inventory. By combining certain site types into categories within this table, site recording differences between

Table 5-2

NUMBER OF SITES BY SITE TYPE AND INVENTORY

Site Type	Existing Total		Phase 1 Stage 1 Only		Phase 1 Stage 2, 3 Phase 2		Other		Total Sites	
1	2	(2)			1	(2)	1*	(1)	3 *	(1)
2	10	(12)	2	(6)	6	(14)	14	(18)	31[1]	(13)
3	13	(16)	1*	(3)			8*	(10)	22**	(9)
4	1	(1)					1	(1)	2	(1)
5	10	(12)	14	(42)	19*	(43)	8	(10)	51*	(22)
6	6	(7)							6	(3)
7	3	(4)	1	(3)	3	(7)	3	(4)	10	(4)
8										
9										
10										
11					2	(5)			2	(1)
12	26	(31)	1	(3)					27	(11)
13										
14	6	(7)	1	(3)	3	(7)	1	(1)	11	(5)
15										
16			5	(15)	5	(11)	10	(13)	20	(8)
17							1	(1)	1	(1)
18			6*	(18)	4*	(9)	31**	(40)	41****	(17)
19			2	(6)	1	(2)			3	(1)
Unknown	6	(7)							6	(3)
TOTAL:	83	(98)	33*	(99)	44*	(100)	78**	(99)	237****	(100)

NOTES: ( ) = percent
* = number of multiple site types
1 = site recorded in existing record and in survey

Other = represents sites recorded by WESTEC outside of sample units

Key to Table 5-2

1 - Village
2 - Temporary Camp
3 - Shelter/Cave
4 - Milling Station
5 - Lithic Scatter
6 - Quarry Site
7 - Pottery Locus
8 - Cemetery
9 - Cremation Locus
10 - Intaglio
11 - Rock Alignment
12 - Petroglyph
13 - Pictograph
14 - Trail
15 - Roasting Pit
16 - Isolated Find
17 - Cairn
18 - Historic
19 - Cleared Circle or Rock Ring

existing records and Class II inventory are readily apparent. Five types of sites are shown in Table 5-3.

Table 5-3

INVENTORY TO NUMBER AND PERCENT
OF SITE TYPES

Inventory	No. of Sites	Habitation	Rock Art	Lithic	Historic	Other	TOTAL
Existing Record	83	30%	31%	12%	-	27%	100%
Phase 1 Stage 1	32	9%	3%	59%	16%	13%	100%
Phase 1 Stages 2 & 3 Phase 2	43	16%	-	56%	7%	21%	100%
Other WESTEC Sites	76	30%	-	24%	38%	8%	100%
TOTAL	234	24%	12%	30%	16%	18%	100%

- Habitation includes sites designated as Village (1), Temporary Camp (2) and Rock Shelter (3).
- Rock art lists both petroglyph (12) and pictograph (13) sites.
- Lithic sites combines both Lithic Scatter (5) and Isolated Finds (16).
- Historic sites have been taken from the site type 18 category.
- "Other" includes the 11 site types not mentioned above; they are milling, quarry, pottery, cemetery, cremation, intaglio, rock alignment, trail, roasting pit, cairn and isolated rock ring or cleared circle.

As shown in Table 5-3, previous emphasis in site recording has been directed to habitation (30 percent) and rock art sites (31 percent) with lithic sites representing 12 percent of the existing record. This is no surprise as the emphasis of archaeology has been and still is directed at studying habitation and rock art sites. Stage 1 random sample data projects that 9 percent of the study area's potential sites are habitation and 3 percent are rock art sites, with 59 percent lithic scatter and 16 percent historic sites. These Stage 1 projections appear to be more representative of the total archaeological inventory, even though this inventory was performed at the 0.025 percent level. The present cultural resource inventory (after WESTEC's Class II inventory) lists 24 percent habitation sites, 12 percent rock art sites, 30 percent lithic sites, 16 percent historic sites and 18 percent "other."

It should also be noted that in the BLM East Mojave Inventory of 2 million acres (USDI-BLM n.d.), just north of this study, a 1 percent sample projected: 13 percent habitation sites; 60 percent lithic scatter and isolated lithic sites; 2.3 percent rock art sites; 13 percent historic sites; 11.7 percent "other." The previously recorded sites (existing record) for the East Mojave P.U. contained: 36.4 percent habitation; 29.6 percent lithic scatter and lithic isolate sites; 20 percent rock art; 0.4 percent historic; 13.6 percent "other." These East Mojave study results are quite similar to Stage 1 results and existing record for this study.

5.2 Site Type Observations

Utilizing the existing record along with WESTEC's inventory and field observations, a series of patterns appear. These patterns include most of the site types and are related to environmental variables and past land use. Site type, including features and artifacts, and related site patterning will be discussed first, followed by area patterning.

1. Villages - All villages are located at active spring locations. Two of the three villages are located in major mountain ranges (Turtle and Chuckwalla); the third village is located near the northeastern end of the Old Woman mountain range, an area which contains approximately 30 percent of the springs in the study area.

2. Temporary Camps - The distance to the mountain base for this type of site, as recorded in sample stages 1, 2, 3 and Phase 2, is an average of 0.66 kilometers. Within these sampling stages, seven of the eight temporary camps were located near major mountain ranges (Old Woman, Turtle and Chuckwalla). Observing the existing record along with WESTEC's inventory, temporary camps are located: along the southern portion of the Eagle Mountains; throughout the Chuckwalla Mountains; in the northern portion of the Old Woman Mountains; the eastern half of the Turtle Mountains; and along the edges of Cadiz, Bristol, Palen and Danby Dry Lakes. A total of 31 temporary camps have been recorded within the study area.

3. Rock Shelters - This type of site can be located easily along Eagle Pass in the Sacramento Mountains, in the eastern half of the Turtle Mountains, and in the northwestern portion of the Old Woman mountain range. The best rock formation for this site type is a granitic boulder formation and Tertiary volcanics.

4. Milling Stations - Milling stations are either not well documented or occur rarely in the study area. Only two milling station sites have been recorded, both of which are near the Chuckwalla Mountains.

5. Lithic Scatters and Isolated Finds - These sites are primarily located near any source of rhyolite, andesite, basalt and cryptocrystalline (volcanic formations especially tertiary volcanic to recent volcanic and metamorphic limestone

formations). These sites were found to be within a range of 0-3.25 miles (5.2 kilometers) from the mountain base.

Lithic scatter sites within the Phase 1 and Phase 2 inventory were classified into the following five BLM subtypes (see Appendix A, Attachment 1):

a) Large, Dense Lithic Scatter - a locus consisting of more than 30 flakes and/or tools per 10 square meters and extending over 50 square meters.

b) Large, Light Lithic Scatter - a locus consisting of fewer than 30 flakes and/or tools per 10 square meters and extending over 50 square meters.

c) Small Dense Lithic Scatter - a locus consisting of more than 30 flakes and/or tools per 10 square meters and extending over an area less than 50 square meters.

d) Small, Light Lithic Scatter - a locus consisting of fewer than 30 flakes and/or flaked stone tools and extending over an area less than 50 meters.

e) Chipping Circle - A loci usually one or two meters in diameter consisting simply of a core with related flakes immediately around it.

The majority of the lithic scatter sites were of subtype b (Large, Light Lithic Scatter) (64%) followed by subtype d (Small, Light Lithic Scatter) (18%) and subtype c (Chipping Circle) (12%) (see Table 5-4).

Table 5-4

SUBTYPE TO NUMBER AND PERCENT OF LITHIC SCATTER

Subtype	Number of Sites	Percent of Sites
a	1	3
b	21	64
c	1	3
d	6	18
e	4	12
TOTAL:	33	100

6. Quarry Sites - Quarry sites are defined as the actual rock formations from which lithic materials are taken. These sites have been located in the Eagle mountain range (Placer Canyon) where Pleistocene volcanic and metamorphic limestone materials are present. Another quarry is located on the east side of the Eagle Mountains in a Tertiary volcanic area, a third reported quarry site is located at the south end of the Coxcomb Mountains near a metavolcanic formation. The fourth quarry area is reported in the northwest end of the Turtle Mountains, an area of Tertiary volcanics. Quarries may not be of high importance here as sufficient amounts of materials suitable for toolmaking can be located on broad alluvial fans, leading from the source area.

7. Pottery Locus - This type of site appears to be associated with pass areas (trails), spring localities and habitation sites. The greatest number of sites with pottery can be located in the Turtle Mountain P.U. This probably results from the proximity of the Colorado River and the higher number of habitation sites and spring localities within this planning unit. Pottery was also located in sites near Palen and Hayfield dry lakes but not in sites near Bristol and Cadiz dry lakes. In Stage 1, only 3 of 27 archaeological sites contained pottery while all 4 of the spring sites sampled contained pottery, again correlating pottery to water and habitation areas.

During the WESTEC inventory, one noticeably different piece of pottery from each site was collected and later typed by Mike Waters. Only five pottery types were identified for the study area and are classified as follows:

a. Parker Buff (Patayan II/III) A.D. 900 - post 1900

b. Parker Red on Buff (Patayan II/III) A.D. 900 - post 1900

c. Tizon Brown Ware A.D. 700 - 1890 (Colton 1958)

d. Colorado Buff (Patayan III) A.D. 1500 - post 1900

e. Black Mesa Buff (Patayan I) A.D. 500 - 1000

The Turtle Mountain P.U. contained all of the five pottery types listed and had the highest number of sites with pottery (Table 5-5). The Palen P.U. contained 3 sites with pottery; the pottery types within these sites were Parker Buff and Colorado Buff. Bristol/Cadiz P.U. also contained only 3 sites with pottery, but the pottery types were Parker Buff and Tizon Brown Ware. All of the planning units contained Parker Buff pottery.

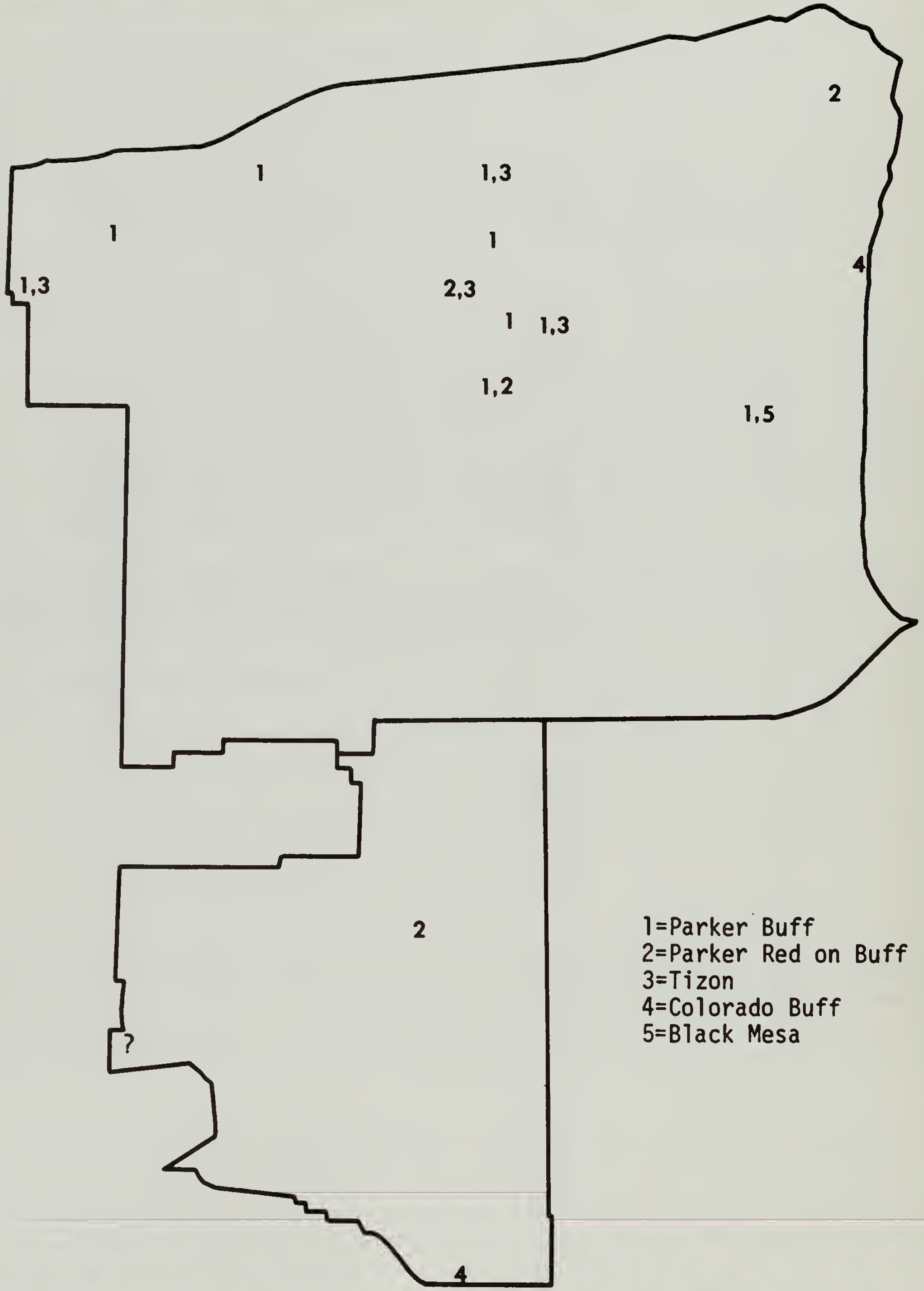
One Black Mesa Buff pottery sherd, the oldest of the pottery types found in the study area, is generally dated between A.D. 500 to 1000. It was located in a rock shelter, in the northeast end of the Turtle Mountains. The greatest concentration of pottery was noted in the northeast end of the Old Woman Mountains where habitation sites and springs are located. A possible line of pottery (Parker Buff and Parker Red on Buff) can be drawn from Needles to Amboy (see Figure 5-1) with the Old Woman Mountains serving as the main source of water between these distant east-west points. All of the pottery types were probably made east of the study area and carried/traded west.

Table 5-5

NUMBER AND TYPES OF POTTERY BY PLANNING UNIT

Planning Unit	Total Sites With Pottery	Parker Red	Parker Red on Buff	Tizon	Colorado Buff	Black Mesa	Uniden-tified	Total Pottery Types Per Planning Unit
Bristol/Cadiz	3	3		1				2
Turtle	11	7	2	3	1	1	3	5
Palen	3	1			1		1	2
TOTAL:	17	11	2	4	1	1	6	

NOTE: Each site may have more than one pottery type.



General pottery locations and types

FIGURE 5-1

8. Cemetery - No cemetery sites have been recorded within the study area.

9. Cremation Locus - One previously recorded cremation locus was recorded in the northeast end of the Old Woman Mountains.

10. Intaglio - No intaglio sites have been recorded within the study area.

11. Rock Alignments - Four rock alignments are located in or near the study area. Three of these are located on the east one-half of the Turtle Mountains; the fourth is located on the south side of the Chuckwalla Mountains. The two rock alignments in Vidal Valley (Turtle Mountains) visited by the WESTEC inventory team appeared to be nonrepresentational.

12. Petroglyph Sites - These sites appear to be associated with trail systems and springs. Examples can be found: along the south end of the Eagle Mountains (north of Hayfield Lake); at Corn Springs and near the western mouth of Corn Springs Pass (Chuckwalla Mountains); at the northeast end of the Old Woman Mountains (this area contains a number of springs and is a possible connecting area for east-west travel); along Eagle Pass and two other trail systems in the Sacramento Mountains; at Barrel Spring; Mopah Spring; and, reportedly, along a trail through the Stepladder Mountains. Approximately 34 of the 39 sites with rock art can be associated with a trail and/or spring. The few petroglyph sites visited were primarily dominated by nonrepresentational curvilinear elements with a few rectilinear elements and even fewer representational elements (connected circles, circle with line through it, stick figure with tail).

In comparing this study area with the East Mojave Study Area (USDI, BLM, East Mojave Planning Units - Unit Resource Analysis) it was noted that while these two areas are nearly comparable in size (Em = 2,000,000 acres; Tu/Bc/Pa = 2,500,000 acre); the East Mojave study area contains nearly five times the number of rock art sites as the Turtle/Bristol/Cadiz and Palen study area (see Table 5-6). Even though there is a greater number of sites within the East Mojave study area, the percentage of rock art sites is very similar. In both studies petroglyphs are the most prevalent form of rock art, followed by pictographs with petroglyphs usually at habitation locations. Pictograph sites are the least frequent sites found in both the East Mojave P.U. and the Turtle/Bristol/Cadiz and Palen study area.

Table 5-6

COMPARISON OF TU/BC/PA TO EAST MOJAVE TYPE OF ROCK ART SITES

Site Type	TU/BC/PA Number of Sites	East Mojave Number of Sites
Petroglyph	36 (92)	162 (88)
Pictograph/ Petroglyph	3 (8)	12 (6.5)
Pictograph	0 (0)	10 (5.5)
TOTAL:	39 (100)	184 (100)

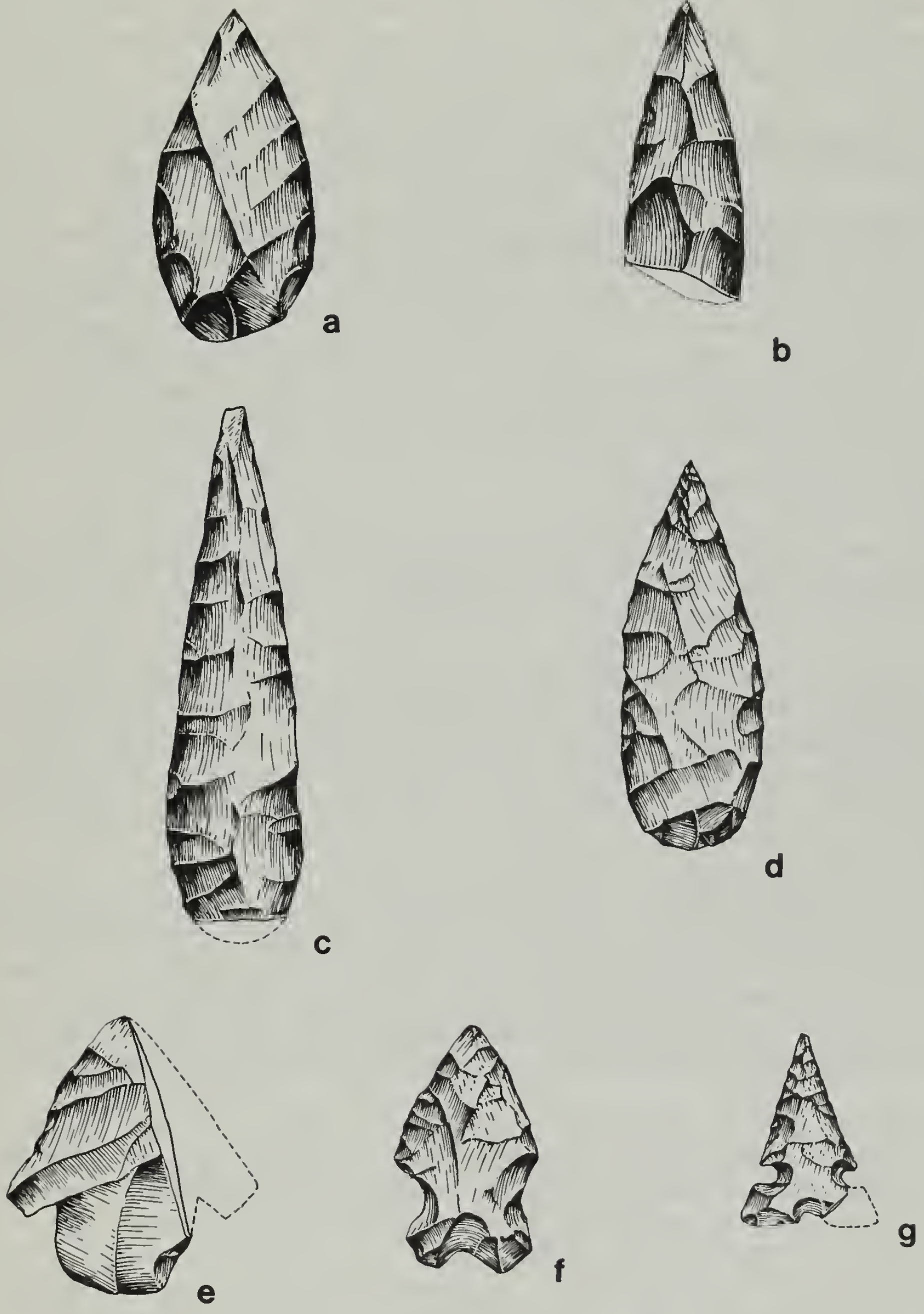
NOTE: ( ) = percent

13. Pictograph Sites - Pictograph sites are exceedingly rare - only three sites contain pictographs. Site one is located at Hayfield Spring (Eagle Mountains); the other sites are at Painted Rock Spring and Sunflower Spring (Old Woman Mountains). Only the Painted Rock site was visited. This site contained red, orange, black and white pictographs, some of which accented the petroglyphs.

14. Trails - Almost all of the trails are east-west oriented. These trails can be found on the east side of the Sacramento Mountains; on all sides and through the Chuckwalla Mountains; at the south end of the Eagle Mountains (Hayfield Lake); Palen Pass extending northeast and southwest; on the east side of the Turtle Mountains; and reportedly east-west through the Stepladder Mountains. Within the Bristol/Cadiz P.U., no trails had been previously recorded or located in the WESTEC inventory. Major east-west trails exist in the Palen P.U. and a number of small east-west segments can be found in the Turtle Mountain P.U. - trail width was approximately 27 centimeters (± 3 centimeters).

15. Roasting Pit - Areas with fire affected rock were located near Palen Dry Lake, but no roasting pit sites are recorded for the study area.

16. Isolated Finds - Isolated finds can be found anywhere in the study area, but are primarily found in and around lithic scatter sites (see discussion on lithic scatter sites). In the course of this study two isolated points were recorded (see Figure 5-2 c and d.) Both of these points are leaf-shaped.



Points from within the study area ranged from leaf shaped a, b, c, d to Pinto-like (f) and Desert-side notched (g)

FIGURE 5-2

17. Cairn Sites - Cairns are recorded on the west side of the Chuckwalla Mountains, west of Corn Spring Pass and in the northwestern portion of the Turtle Mountains. The three cairns on the west side of the Chuckwalla Mountains are in association with seven rock rings, two trail markers, one upright rock, one trail, lithics, and a large pile of rocks with an opening in the center. The cairns near the Turtle Mountains are also associated with lithics, rock rings and a trail.

18. Historic Sites - No historic sites were recorded before the WESTEC Services inventory. There are presently 41 historic sites (see Section 6 for discussion).

19. Isolated Rock Ring or Cleared Circle - This site type was probably the outline of a previous sleeping area. One rock ring was located in the Eagle Mountain intermountain catchment area, and another single rock ring was located on the east side of the Turtle Mountain range. Rock rings and cleared circles were noted on the west side of the Chuckwalla Mountains; on the northeast side of the Turtle Mountains, an area was located with rock rings in association with a trail and cairns.

5.3 Site Patterning Observations

Five areas have been singled out which represent site patterning. The BLM site type definitions used can be found in Appendix A, Attachment 1. Figures for these areas can be found in Appendix N (unpublished).

- Area 1: This area includes the Bristol, Marble and Clipper Mountains. Assuming a single subregional block contained all of these mountain ranges, including a three-mile perimeter extending from the base of each mountain range; and then using Stage 1, 2 and Phase 2 sample units within this sample universe, a potential of 8 sites per square mile is projected for this area. Of the sites located in this sample universe, 83 percent are lithic scatter or isolated lithic sites. The reason for the high number of sites and the type of sites can be explained by the area's proximity to the Granite Mountains to the north, where a number of springs and habitation sites are located and also this area is composed of Tertiary volcanics, Miocene volcanics and metamorphic limestone which produce rock material suitable for stone tools. The Granite, Bristol, Marble and Clipper Mountains provided complemental resources for past peoples. The Granite Mountains provided water and habitation, while the Bristol, Marble and Clipper Mountains provided rock material for stone tool making (also see Appendices H and I).

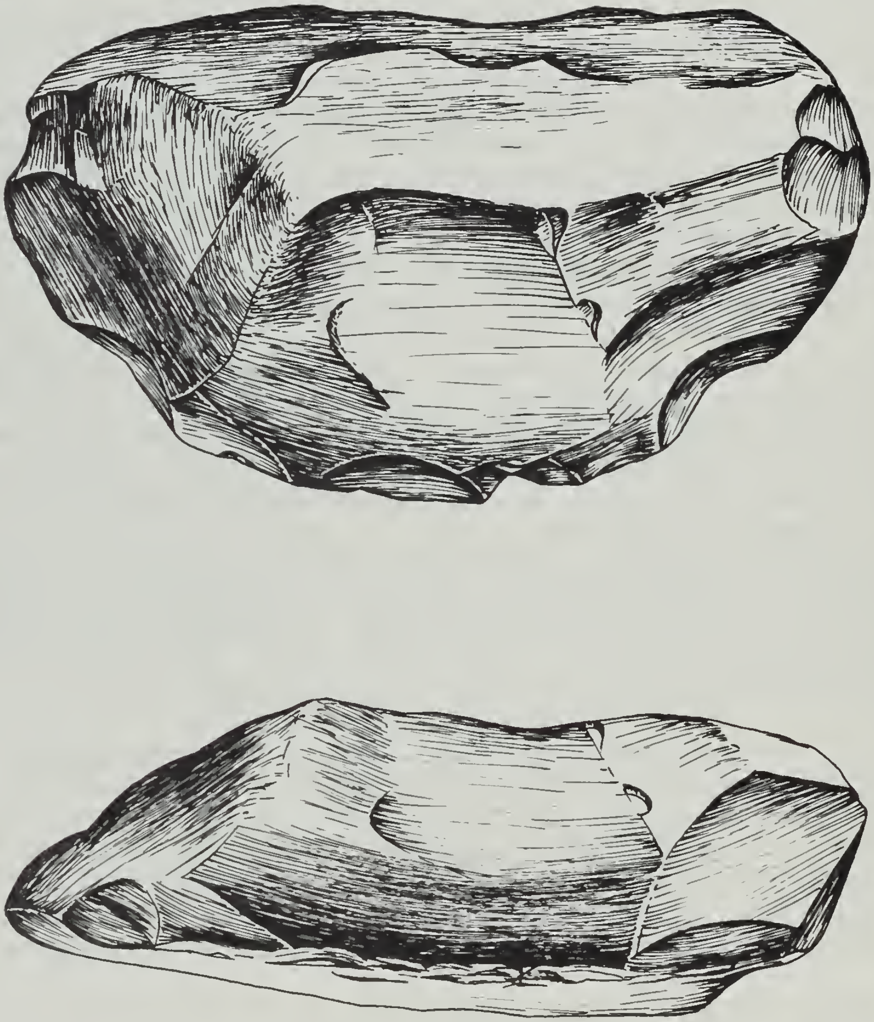
- Area 2: The Sacramento Mountains are over 70 square miles in size and reach an elevation of 3314 feet. Four noticeable natural passes afford easy east/west passage between the Needles/Colorado River area and the southern California desert. Two of the three passage areas are known aboriginal trail areas with a number of rockshelter and petroglyph sites along the trail. The third passage area contains a rockshelter and two petroglyph sites. Other small trail segments also contain either petroglyphs or rockshelter sites. The west side of the Sacramento Mountains contain a high number of sites. Generalizing from the 4 transects surveyed on the west side of the Sacramento Mountains which produced 4 sites, a projection of 8 sites per square mile is roughly figured for the west half of the Sacramento Mountains (4 transects (320 acres) = 4 sites, then projecting for 640 acres (square mile) = 8 sites per square mile). Explanations for the high number of sites for this area (see discussion in Section 3, Phase 2 results) can be attributed to: 1) the proximity to the Colorado River (an area of high aboriginal activity); and 2) trade and travel to and from this high activity area.

- Area 3: This area encompasses all of the Chuckwalla Mountains, the largest mountain range in the study area (approximately 140 square miles in size). Four springs are located in this range, all of which contain archaeological sites. East-west trails cross the north, center and south ends of this range. The southern area, where three of the four springs are located, contains a high number of sites which run from trail to lithic scatter to village. The center area is bisected by Corn Spring Wash, which is a well-known petroglyph site and trail area. The western portion of this trail appears to disperse in northwestern to southwestern directions or vice versa. The sites in this western area include lengthy trail segments, cairn areas and rock ring and cleared circle areas (see Figure 5-3).

- Area 4: The Turtle Mountains is another major mountain range (approximately 120 square miles in size) with a high number of springs (5). This range is geologically divided by Tertiary volcanic on the east and Precambrian igneous and metamorphic rock complex on the west. If the mountain range were split down the center, the majority of water and lithic resources would be found on the eastern half. A somewhat equal sampling of the eastern and western halves can be made with 10 sample units on the west and 11 sample units on the east. The return for the 10 transects on the west was 2 sites, or a little more than 2 sites per square mile on the average. The eastern half produced 17 sites, or roughly 12 sites per square mile. The eastern half (based on sampling and the existing record) projects a higher number of sites (see Figure 5-4). This can be attributed to the presence of Tertiary volcanics, desert pavement, intermountain catchment areas, springs and general proximity to the river. Perhaps past activity was primarily directed to the Colorado River, which is closer and more accessible to the east side of the mountains.

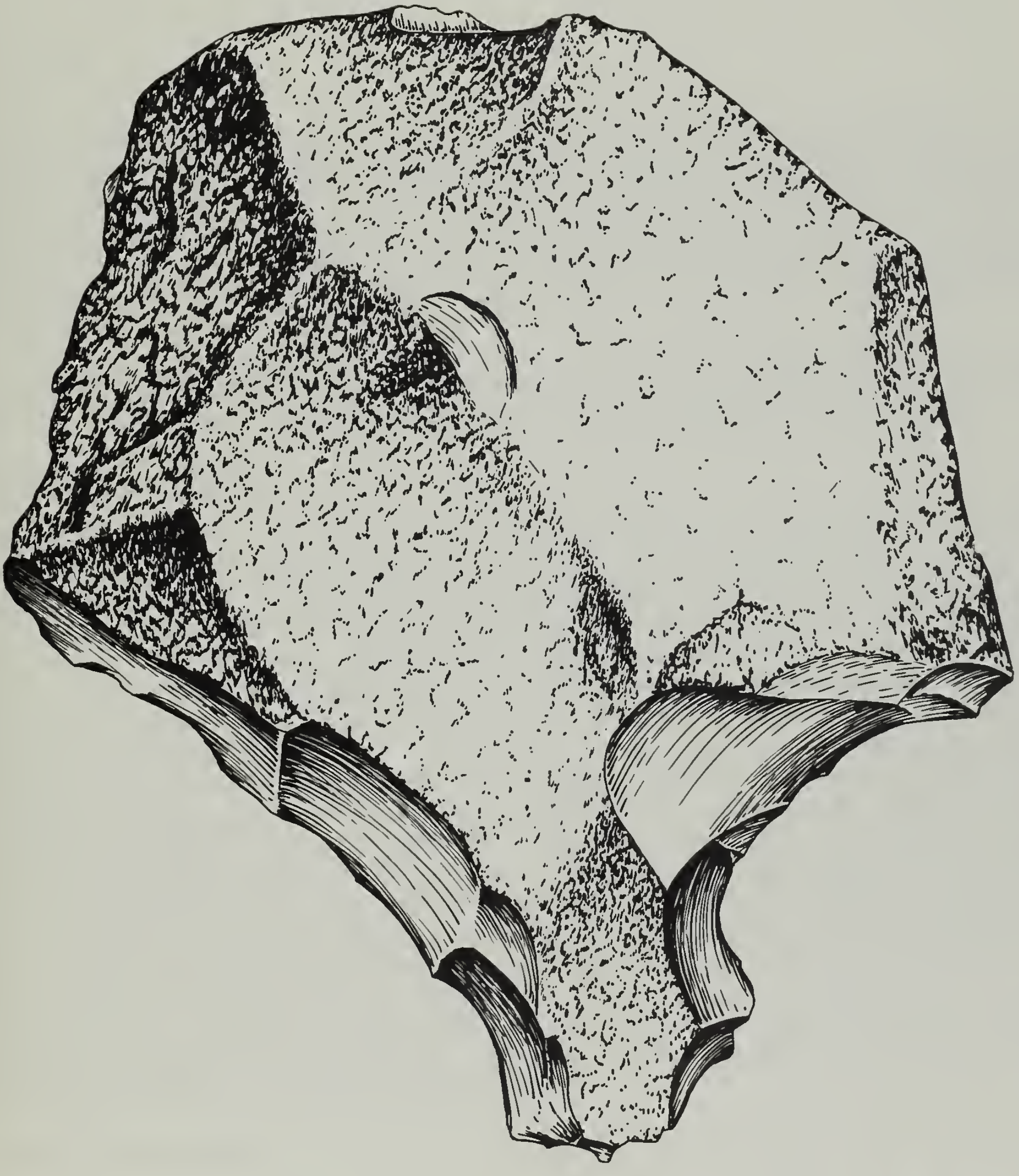
- Area 5: The southern end of the Eagle Mountains (Hayfield Lake area) contains numerous petroglyph and habitation sites. A major east-west trail passed along the southern end of the Eagle Mountains. Near this trail are petroglyph and habitation sites. The trail continues west into a natural pass between the Eagle and Orocopia Mountains. The pass funnels all east-west traffic into this area, as well as the attraction of springs, a possible marsh situation at Hayfield Lake, and intermountain catchment areas, which contain yucca and cactus, within the Eagle Mountains.

- Area 6: Area 6 encompasses the northeast end of the Old Woman Mountains. This area has been singled out because it contains eight springs and three more springs within five miles. Thirty-seven percent of the springs for the study area can be found here. The area also contains numerous granitic boulders for rockshelters and was probably a stop-over spot for east and west travel from and to the Needles (Colorado River) area (see pottery site type discussion). Numerous rock art, habitation and pottery sites have been previously recorded for this area. The potential for more sites in this area is expected to be high. Two of the three sites with pictographs in the study area are in this Old Woman Mountain area.



Stone tool from site PA-8, Chuckwalla Mountains

FIGURE
5-3



Stone tool from site TU-217, Turtle Mountains

FIGURE 5-4

SECTION VI

HISTORY

By Frank Norris

6.1 Introduction

The inventory of historical resources was approached using two methods. First, an overall historical review was performed, using available literature and USGS maps to delineate historical site locations. As many of these sites as possible were visited, recorded, mapped and photographed. Second, the sampling inventory was used to provide an estimate for the types and number of historical sites within the study area. Both inventory methods were necessary to provide a comprehensive view of the historical resources.

This section provides a general historical overview, a historical background, a historical field inventory of select areas, and the sampling inventory and results.

6.2 Historical Overview

Presently, the study area appears to be the least historically impacted area in the California desert. In the past, numbers of people settled in this area but relatively few do so now. The opportunity for settlement has been small; Needles is the largest town. In addition to Needles, only 10 small communities exist. They are: Amboy, Cadiz, Camino, Desert Center, Eagle Mountain, Essex, Hayfield, Rice, Saltus, and Vidal Junction. All of these communities are either related to transportation or mining. Otherwise, the area is presently devoid of a hinterland population; this lack of population is an obvious reflection of the lack of job opportunities. Because the area is exceedingly dry and uncomfortably hot in the summer months, economic enterprises are few. Irrigated agriculture can only be attempted within a small portion of the study area and, in comparision to the California Desert Conservation Area (CDCA), has hardly been attempted. Much of the settlement is attributed to demands for highways, railroads, transmission lines, aqueducts and other transdesert linear features; only mining and grazing are truly supported by the land. Grazing has been an insignificant economic endeavor which has left few traces of its existence. Mining successes have attracted many to the study area, though even mining is less important there than in other CDCA areas. Long-term mining enterprises have existed only at Eagle Mountain and on Bristol Dry Lake. The large majority of other mining claims have been of either short-term duration or sporadic small-scale use.

6.3 Historical Background

It is not the purpose of this report to fully document historical events; however, a brief outline of selected events is presented as a guide to the identification of the various historic sites recorded.

The first Europeans to enter the Eastern Mojave were those who traveled with Francisco Garces. An inveterate traveler, he first entered the California desert in 1771. In a second trip during 1776, he traveled north through the Western Chemehuevi Valley stopping at several places along the way, including a spot he called Santo Angel. Santo Angel appears to roughly correspond with today's Mopah Spring, although Garces' descriptions are not sufficiently definitive to be accurate. He continued traveling north to the present-day Needles area and then turned west on an Indian trail near what would later become portions of the Old Government Road.

In the 1820s Jose Romero and Jose Maria Estudillo entered the study area twice, first failing and then succeeding in finding a route east from the present-day Indio area to the Colorado River. During the same period, the Cocomaricopa Trail, a well known aboriginal-trade route, saw increased use as an occasional mail route between Sonora and Alta California. No permanent European settlements were recorded during this period.

After the American acquisition of California in 1846-48, few immediate changes occurred in this part of the desert. The land was virtually uninhabited until the early 1880s when the Atlantic and Pacific Railroad (now the Santa Fe Railway) laid its tracks across the northern end of the study area. A number of railroad sidings with section houses to provide support for the railroad maintenance were established. Their names were alphabetically arranged such as Amboy, Bristol, Cadiz, Danby, and Epson (later Essex). Additional stations were established at Java, Hartoum (Khartoum) and The Needles (later Needles). In 1910, a railroad line was established between Cadiz and Parker with railroad siding names of Archer, Chubbuck, Fishel, Milligan, Ward (later Saltmarsh), Sablon and Freda.

As in other areas of the desert, Anglo mining activity began in the late 1880s. However, the first major strike did not occur until the Old Woman Mountains boom of 1898-1901. Previous to World War I, the Orange Blossom and other mines opened for short periods of time. By World War I, a tungsten boom had brought a small influx of miners back to the Old Woman Mountains; the Chuckwalla Mountains also experienced some mining during this period. Large-scale salt extraction activities began on Bristol and Danby Lakes shortly after 1900. Many other mines have been established since World War I, but with the exception of the salt and gypsum deposits noted above and the iron deposits developed in the Eagle Mountains shortly after World War II, most have been rather unsuccessful ventures.

Roads and their consequent settlements have been a more permanent mark on the landscape. Consistent, large-scale use of desert roads did not begin until the 1920s, consequently few roadside settlements are historic sites (over 50 years old). Most of the older settlements, those built shortly after road paving, such as Desert Center and Chambless, survived many years, while many of the more recent stops such as Road Runners Retreat, Twelve Mile Station, Hell and Skylark Ranch lasted only a short while.

Other types of transportation facilities have impacted the study area. Construction of the Metropolitan Water District (MWD) Aqueduct in 1934-41 created a "boom town" atmosphere in Rice and Desert Center, and also resulted in the construction of several MWD company towns at pumping plants. The Boulder Dam project, in the 1930s brought a major transmission line through the area, and produced a small settlement at Camino.

In the 1940s, Patton's Desert Training Center for war maneuvers produced major impacts to the study area since all three planning units fell within the center. The military did not build a permanent settlement, and the visible remains of this activity are settlement outlines, tank tracks and shrapnel. During this period, the populations of Desert Center and Rice were bolstered, but they quickly declined after the war.

6.4 Sampling Strategy

The sampling strategy described in Section 3 was also applied to the historical resources inventory. The assumptions and objectives discussed earlier (Section 3) are not completely applicable to the historical period, because they are directed at aboriginal land-use patterning and do not conform well to past historical activity. For example, the historical period was not as dependent on native plant resources and could be located along transportation corridors independent from water (springs). A separate sampling strategy could have been constructed to center on the sampling of transportation corridors, mining areas/mineral deposits, water and settlement areas. This type of sampling strategy was not deemed necessary to answer questions of site density and site patterning; a combination approach of sampling, literature search, and field inventory was used in this study.

6.4.1 Sampling Results

The 0.025 Stage 1 inventory produced five mining sites and one transportation-related site (see Appendix A, Attachment 1 for Historical Site Types). All of these sites were located in the Valley Bottom or Mountain/Hill Stratum, with an average distance to mountain base of 0.33 kilometers. According to Zvi Brenner's landform categories (1978), the landform for these sites is classified as either hills or pediments. The vegetation for historical sites was creosote bush shrub. The projection of historical sites for the total study area, based on this 0.025 sampling, is 2400 historical sites.

Total sampling inventory produced 10 sites; 9 related to mining and 1 to transportation. Five of the 10 sites are mining camps, ranging in size from 9 to over 80,000 square meters. Slope for these sites was near level and distance to mountain base averages 0.27 kilometers (see Appendix L).

6.5 Select Area Field Inventory

This inventory is intended to furnish an overall summary of the historical resources within the study area. It was beyond the scope of this project to visit each one of the over 200 site locations and record information. Therefore, a two-step process was used. First, some of the better known locations for historic resources were field surveyed. Second, these data were combined with earlier sample inventory historic site records and previous field interviews to obtain as much specific site data as possible. Both field-survey data and interview-based data were copied onto historic site forms (Appendix A, Attachment 4) as well as onto archaeological site forms. The visited sites were then divided into the following six classes (see Appendix L).

- Type 1 - Sites in which most or all of the materials are considered historic (over 50 years old or associated with a significant event or activity, such as World War II). These sites must also be in good condition.

- Type 2 - Sites containing both historic evidence and a substantial amount of nonhistoric evidence (recent material).

- Type 3 - Sites which are primarily historic, but the historic evidence is in poor condition.

- Type 4 - Sites possessing historical significance, but lacking in physical on-site evidence (i.e. location of an event).

Other sites, not currently possessing historic value (less than 50 years old) are classified type 5 and 6.

- Type 5 - Nonhistoric site in good condition.

- Type 6 - Nonhistoric site in poor condition.

SECTION VII

FUTURE DIRECTION

The direction for future work and orientation is extremely important as the archaeological focus will prevail when participants are interchanging. Numerous personnel changes along with archaeological whims will occur in the next ten years. Therefore, specific research goals and research orientation should be defined at the earliest possible date. This can be accomplished by: 1) a contract for a research design or 2) a BLM meeting with concerned archaeologists to prepare a research design. The research design should be reviewed by and have the support of the scientific community, native Americans and BLM management because this design will be the orientation for future work. BLM personnel and BLM contractors should be periodically briefed with regard to research goals and updates of these goals as necessary. This will provide both continuity with past programs and on-going research.

Future archaeological investigations should use and involve past work as much as possible including field data collection methods. This will insure that data from one investigator or project can be measured, analyzed or, hopefully, combined with previous work at a later date. It is hoped that once direction and procedure are adopted and developed, archaeologists will be able to build in a positive manner, rather than inventing the wheel each time they go out into the field.

The program may encumber small projects or specific research interests. However, it is believed that in the long run, data applicable to researchers, native Americans and managers will be sought to accomplish a greater understanding of past peoples.

In addition to research goals and orientation, a major effort should be made to gather environmental data from dry lakes, rat middens, and other sources. This information will provide the base line data necessary to bracket archaeological materials within appropriate environmental settings. One must know the environment to understand the pressures upon past peoples who were tied directly to that environment.

BLM should seek out and develop a record of any dates (i.e. C-14) in association with archaeological sites and artifacts. BLM's focus should also include the documentation and protection of major archaeological sites (i.e., habitation and rock art), as these areas will suffer the greatest visitation and misuse.

The Desert Planning Program has begun the inventory of cultural resources. Numerous transects have been inventoried and data collected. It would seem appropriate to build upon this data base and general strategy, utilizing each planning unit or planning units as study areas, depending on how the previous Planning Unit Resource Analysis data was gathered.

SECTION VIII

SUMMARY

8.1. Inventory Description

The project involved the largest areal cultural resource inventory within the State of California. A total of 13,440 acres (168 transects) were inventoried (within a 2-½-million-acre study area). The inventory was primarily a sample based survey complemented with purposive inventory of select areas. Beginning in late May of 1978, the project required all field work to be completed during June, July and August, the hottest and most uncomfortable time of the year.

The area studied encompassed the Turtle Mountains, Bristol/Cadiz and Palen planning units. It is bounded by Joshua Tree National Monument, the Colorado River, Interstate 40, and Interstate 10. This area is characterized by broad alluvial fans draining into the basin area of Bristol, Cadiz, Palen, Dale and Hayfield lakes, a creosote bush scrub vegetation, and mountain ranges that rarely exceed 4,000-foot elevations.

Sample inventory was based on Margaret Weide's (1973) objectives and assumptions (Section 3) developed for the BLM Cultural Resource inventory of the California Desert. In brief, the assumption follows that extraction of economic resources was a significant determinant of the land-use patterns practiced by aboriginal inhabitants of the California Desert. Therefore, location of prehistoric sites will have a regular relation to the distribution of economic resources used by past inhabitants, and site density and locations can be generated for management purposes. Historic sites, not as patterned as prehistoric sites to the environment, could be found along transportation corridors independent from natural water sources (springs) and native plants. This discrepancy necessitated a historical purposive inventory of select historical sites especially along transportation corridors.

8.1.1 Inventory Phases

The three inventory phases and subsequent purposive inventory of select historical sites are described as follows:

Phase 1

This phase was divided into three stages - 1, 2, and 3.

- Stage 1 was a nonarbitrarily stratified, systematic sampling design using geomorphology and vegetation as the stratifying variables.
- Stage 2 consisted of an increase in Stage 1 sampling within select strata.
- Stage 3 involved the systematic sampling of six of 32 springs within the study area.

Phase 2

Phase 2 consisted of subregional block sampling. In this strategy sample units were directed to randomly selected blocks in order to examine and clarify apparent environment/site relationships noted in Stage 1. Subregional block sampling uses the concept that a sample from randomly selected blocks will reflect the larger homogenous sampling stratum. In this case, the subregional blocks were four miles wide beginning within each mountain range and extending outward three miles. Blocks were approximately 20 sections in size and were sampled at the 2 percent level.

Phase 3

Phase 3 was a purposive (judgmental) field inventory of the dry lakes and dune systems supervised by Dr. Emma Lou Davis. These environmentally complex areas could not be understood through the low levels of systematic sampling, and a nonrandom approach was used (see Section 4).

8.2 Site Patterning

Utilizing 15 minute base maps and mylar overlays to visualize site patterning, the following observations were made:

1) Nearly all trails run east/west and appear to be in association with habitation and rock art sites;

2) Mountain ranges rich in potential lithic resources and identified lithic sites appear associated with areas nearby which were rich in water resources and habitation sites;

3) Parker buff pottery was located from the Needles area west across the Old Woman Mountains to the western edge of the study area (Amboy Crater location).

Patterns such as these point out the relationship of site types to both environmental and cultural variables.

8.3 Locational Determinants

The three phases of inventory resulted in the following determinants which appear to influence the location of archaelogical sites:

- Water Resources

    1. Springs
    2. Proximity to the Colorado River
    3. Intermountain valleys (catchments)
    4. Certain lake/dune systems

- Geomorphology/Geology

    1. Mountain/Valley Interface
    2. Hills/Pediments
    3. Desert Pavement areas
    4. Older geologic deposits (i.e. Pleistocene nonmarine)
    5. Lithic resource areas (i.e. cryptocrystallines)
    6. Unique areas (i.e. Lava)

The locational deteriminants suggest not only the presence but preservation of sites on hills and pediments, older alluvial fans and desert pavement areas, but also the lack of sites upon the relatively newer, more active fans located farther from the mountain base. Water resources are among the strongest site indicators, including not only spring localities, but also intermountain catchments (valleys), shorelines of present dry lakes and proximity to the Colorado River. In addition to these determinants, the ethnographic record, existing archaeological record and site patterning were used to delineate areas of higher site probability (Appendix M)(unpublished).

8.4 Site Projection

The sample universe for Phase 2 is 40% smaller than the Phase 1 sample universe. This was shown to have not adversely affected site density projections. Overall archaeological site projection ranges between 6000 and 14000 sites. It was also noted in a test to estimate the gain in precision between stratification and simple random sampling that stratification is an improvement.

8.5 History

Historically, the study area appears to be the least impacted zone within the California Desert. The combined historical inventories (sampling and purposive) present a picture of numerous small mining towns and transportation corridors (ranging from trails to railroads and water aqueducts, gas and electric transmission corridors). The World War II Desert Training Center, commanded by General Patton, was the last major historic intrusion. The vehicle tracks and ordnance refuse from this camp give evidence to the fragility of the desert landscape.

8.6 Recommendations

The results of the study have provided information necessary to delineate areas of higher site probability, density estimates and to predict locations of differing activities. Recommendations as an outcome of this project are: 1) develop a research design to direct all future cultural resource work; 2) utilize the Planning Unit or planning units as study areas from which to build upon the completed Desert Wide Resource Analysis (DWRA), 3) continue studies of the past environment in order to place archaeological materials in perspective to the environmental sequence; 4) standardize field procedures in accordance with the desert planning program inventory so that future work can add and enhance past work; 5) require a minimum one percent level of inventory for all major surveys (ten percent would be ideal); and 6) protect select areas, especially springs, rock art locations and desert pavement areas.

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